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DISRAELI KOBAK, M.D., Editor

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DOSAGE MEASUREMENT IN SHORT WAVE DIATHERMY *

EUGEN MITTELMANN, Eng.D., Ph.D.

and

DISRAELI KOBAK, M.D.

CHICAGO

From the very inception of short wave transmitters for therapeutic purposes, clinicians have universally voiced their dissatisfaction with the existing means of dosage measurement. Down to recent date estimation of the intensity of the heat created in a treated region by short wave diathermy has been found to be scientifically inexact and clinically unreliable, owing to one's entire dependence on the subjective sensation of the patient. This circumstance has led to abusive and empirical practices, which has resulted in burns, prolonged painful sensations and the encouragement of "trial and error" technics. The situation confronting the profession today may be compared to one in which an individual is forced by circumstance beyond his control to employ a boat without rudder or compass or without a meter for a galvanic or diathermy treatment. Need for reliable dosage measurement in short wave therapy equal to the standard set by pharmacotherapy is at present definitely appreciated and has provoked sporadic efforts which unfortunately have fallen short of their promise until the problem was studied from an original physical principle of short wave energy distribution.

The present confusion concerning the basic principles operative to reproduce effective dosage control in short wave application emphasizes the need for restatement of the fundamental facts involved, and the addition of further evidence to prove the soundness of our thesis. This can be more clearly explained and demonstrated by a brief review of the problem from both its physical and biological characteristics. In order not to overburden the body of this report with certain technical arguments best expressed through the rigid medium of mathematical formulas and equations, it was deemed advisable to append this part of our discussion toward the end of this contribution.

Problems of Dosimetry

The total primary energy which is drawn by a short wave generator from the electric power supply is converted into heat corresponding to the various losses in the transformers and other components, partly into the energy which is necessary to heat the filaments of the rectifier and generating tubes, and finally into heat losses in the plates of the generating tubes. The remaining energy is converted into short wave oscillations, which are again divided into two components mentioned in one of our previous reports.[1] The first of these is radiated into the air-space and is known as the power associated with radiation losses. This portion of the high frequency energy depends on the size and distance of the electrodes and is usually augmented by extension of air spacing and by increase of electrode area. The second part of the high frequency energy is of especial interest to us as a unit in itself, when considered from its therapeutic value. This is the energy which is absorbed by the body under treatment. This component will generally increase with the greater area of the electrodes, with the extension of the volume between the electrodes, and will decrease with the air-spacing between the object and the electrodes. The total high frequency energy, that is to say, the sums of radiated energy and the energy absorbed by the body signifies the total high frequency output of the short wave generator.

* From the Department of Physical Therapy, Rush Medical College, University of Chicago.
* Read at the Seventeenth Annual Session of the American Congress of Physical Therapy, Chicago, September 15, 1938.

The power absorbed by the body itself may be identified as the "patient-power."

The amount of warmth measured in calories and the corresponding rise in temperature in a given phantom are directly proportionate to the number of watts and indicate the power absorbed. The rise in temperature is a secondary effect due to power absorption, and may depend on other intrinsic factors, such as the heat regulating mechanism, or the cooling of the circulating blood and other physiologic responses, all of which are motivating influences in the final rise of temperature. A prediction of a subsequent rise in temperature in the living human tissue depends upon certain of the mentioned responses, and is so complicated that no solution can be anticipated without an exact knowledge of this relationship. Typical for this situation are the results obtained in some temperature studies in human beings. When subjects treated with short wave currents had their intramuscular temperature measured, it was noted that with the same amount of current a maximum degree of heat was achieved in about ten or twelve minutes, which then gradually declined to a lower level where it was so maintained (Bierman[2]). The final maximum temperature reading is therefore not to be interpreted as the constant or peak measure for the dosage applied, because under other circumstances it would even be possible to achieve a higher final temperature reading by longer irradiation and with lower dosages.

Nowhere is the contrast greater between short wave and pharmacotherapy than is illustrated by the technic advocated in their respective study of dosage measurements. In the former the attitude of applying maximum heat tolerance as a measure or indicator of clinical dosage is a blind and dangerous approach fraught with failures long guarded against in the study of pharmaco-dynamics. Such treatment soon gives rise to overheating and even to painful sensations if and when the patient's sensory organs are normal, or to burns which may lead to malpractice involvements (Krusen,[3] Kling,[4] Kovács[5]). In pharmacology the dosage of any drug is determined by its physiologic effect in relation to its minimal action. The same sound principle could well be extended to short wave therapy for physiologic dosage by a method that would control the magnitude of the applied primary effect of predetermined wattage input as reliably as that which has guided our practice with conventional diathermy. As in pharmacotherapy our therapeutic objective should be based on the dictum of measured dosage control within physiologic limits.

This and nothing less is the problem of dosage control in short wave diathermy; namely, a means of control which would enable us to reproduce and duplicate treatments with regard to safety and clinical guidance. If a method now at hand gives promise to accomplish this long-sought objective regardless of wavelength and the type of generator, it behooves us to give it fair trial and resent any theoretic, specious and academic arguments that are certain to delay its advance.

The necessity for an exact indication of the patient's input power can be further illustrated by the following observation. There is at present a general assumption that with increase of air-space or distance between body and the electrodes the power absorbed is augmented. Although this assumption is correct in most instances, the reverse may be true when dealing with longitudinal treatments (extremities) in the same plane, as is shown by the higher power absorption achieved with wider air spacing. At first glance this paradox may be explained by the better "matching" of the generator to the external resistance as represented by the object under treatment. From the position of the electrodes alone, the amount of depth penetration or energy distribution is fairly well perceived. To obtain a more complete description of a treatment, an explanation of the energy absorption under the given electrode conditions is necessary.

From what has been said about power absorption and the position and size

of the electrodes it is evident that the primary mechanism in our treatment has its definite limitations. What is the primary mechanism, and what has it to do with selective heating? With the description of the size and distance of the electrodes the measurement of the total power absorbed by the body becomes a well defined magnitude provided the factor of exact wattage control is within our power. The question concerning energy distribution in the various parts of the tissues (fat, bone and muscle) while of theoretic importance, is only of limited value in clinical practice. Exact measurement has not as yet been possible even in phantom experiments where either homogeneous or mixed tissues were employed. It should be recalled that the various studies of different heating effects were made on homogeneous objects, and were only compared with each other in vitro. Such favorable conditions cannot be duplicated in the living subject. It is appreciated that knowledge in this instance of the exact energy distribution would be of more than academic value if we were able to elect any part of the body for selective heating without temperature convection to adjacent regions. Even here it can be shown by phantom experiments that the energy distribution with a given electrode combination can be easily determined and estimated in percentage of power absorption.

Practical Dosimetry

In the October 1937 issue of the ARCHIVES, one of us (M) described an instrument which permitted the measurement of the power absorbed in the patient.[1] Since the publication of this paper the instrument in question has been greatly simplified and its accuracy perfected. The physical and technical principles upon which it is based are dealt with in the Appendix to this paper. The same type of apparatus can be employed regardless of the kind of electrodes employed (air spaced, cuff, or induction coil). The manner in which dosage measurement is performed with this improved instrument is similar to that which has already been described in the above mentioned publication. (For further details see Appendix.) The operation of the instrument is simple and does not involve special calculations or even calibration charts, but depends upon the automatic indications of a special wattmeter coupled with the short wave generator as a method of dosage control (fig. 1).

The accuracy of the indication of the power absorbed within the tissues and independence of geometric configurations between object and electrodes are both demonstrated (fig. 2). Use was made of phantoms of various sizes of electrolyte solutions subjected to different electrodes and variable sized air spacing. The dimensions in the first column shown in figure 2 are given in millimeters. The second column indicates the volume of the solution in cubic centimeters; the third, the power absorption in watts measured by exact calorimetric methods. (The higher figures in this column indicate the power absorbed in the solution, the lower ones correspond to the equivalent heat losses in the glass container.) The indications as given by the dosage control wattmeter are depicted in column 4, and finally, the percentage error of the instrument is computed in the last column. It is interesting to observe that all deviations from the exact calorimetrically determined value are in the same direction.

For purpose of calibration of the instrument itself, we made use of an electrolytic solution of the same conductivity found in human tissues. It may be noted that physiologic salt solution has not the identical conductivity but the same osmotic pressure as human blood. The concentration with the same conductivity is about 1/9 of the normal salt solution. Control tests made with phantoms of long glass cylinders were controlled with various salt solutions and with different electrodes (fig. 3).

The next step was to obtain some initial information about the magnitude of the patient's power absorption corresponding to the various clinical demands of everyday practice. In this connection, knowledge of the total

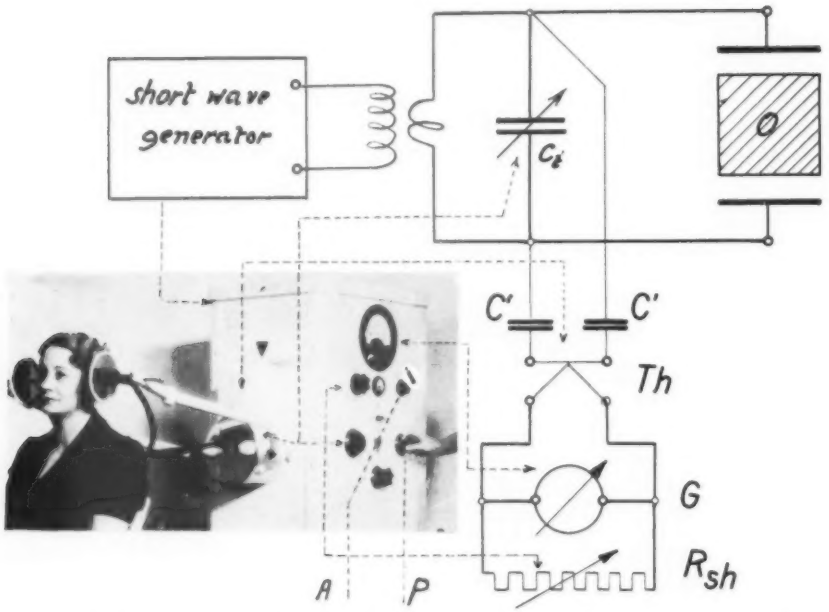


Fig. 1. — Schematic diagram of a high frequency wattmeter to indicate power absorption. G, Galvanometer; R_{sh}, calibrated resistance; Th, Thermocouple; C', coupling condensers; C_t tuning condenser. P, power output control; A, adjustment for G; O, object.

output of the short wave generator gives no idea regarding the actual power absorbed in the body, and is at best rather misleading. This total power output is mostly measured under entirely different conditions (lamp phantom tests). Studies of the factual patient's power absorption has shown that but a fraction of the total output of the apparatus is utilized by the individual. We arrrived at a fair estimate of this requirement after repeated observations of the actual energy load absorbed in terms of tolerance and registered wattage by analysis of living material treated through the thorax. The first attempts to obtain these informative values were carried out by one of us[6] (M) in 1933, with the aid of a substitution method of power measurement. The data arrived at indicated a value of about 100 watts of power absorption

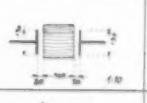
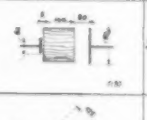
	VOL cm³	W.cal	W.inst	Error %
	5000	43.0 2.1 45.1	47.5	+ 5.3
	5000	78.5 3.9 82.4	84	+2
	1000	113.0 1.0 114.0	117	+3.5

Fig. 2. — The independence of the wattmeter indication from size and position of both objects and electrodes is demonstrated by calorimetric control measurements. W.cal = power absorption as calculated by calorimetric measurement; W.inst = power absorption indicated by direct reading dosage control instrument. Both values are given in watts.

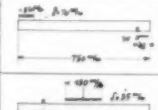
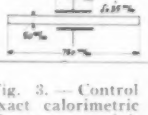
Relat. position of electrodes	Watts calorim.	Watts instrum.	Error %	Salt-Concentration
	106.8	111	3.8+	0.2 norm
	65	63	3-	0.8 norm
	35	31.9	9-	0.2 norm
	38	34	10.4-	0.8 norm

Fig. 3. — Control of wattmeter indications by exact calorimetric measurements. Longitudinal phantom containing 1340 Gm. electrolytic solution. Both measurements with the 0.2 concentration were made with the same setting on the power output control of the generator. The higher power absorption in the first case is due to the better matching between generator and load resistance.

as the maximum of body tolerance for a prolonged treatment. The wattage power thus utilized may be considered as fairly accurate, because repeated and independent measurements with various methods and by different authors are agreed in the matter of magnitude of power required. Table 1 is a short summary of the measurements thus obtained.

TABLE 1. — *Maximum Values of Absorbed Power in Local Treatment (Thorax: Antero-posterior Electrodes) at Limit of Patient's Tolerance.*

No.	Date	Author	Wave	Exposure	Air-Space	Max. Power
1	1933	Mittelmann	14 m.	1 min.	5 cm.	110 watts
2	1937	Mittelmann	6 m.	1 min.	4 cm.	100 watts
3	1937	Wenk	6 m.	few secs.	not recorded	140 watts
4	1938	Kowarschik and Weisz	8 m.	3 min.	4 cm.	102 watts
5	1938	Kobak and Mittelmann	8 m.	3 min.	4 cm.	104 watts

The diameters of the electrodes used in these tests were 250 mm. for No. 1; 180 mm. for 2 and 3; 130 mm. for 4 and 5. So far as concerns the total high frequency output of the apparatus as tested by lamp phantoms, the amounts varied between 700 and 210 watts. Substitution methods were employed in which the subject was replaced by an electric phantom (tests No. 1 and 3) in which the same resonance curve was used as in the patient's circuit. Measurements No. 4 and 5 were carried out by the improved type of Mittelmann's dosimeter, while test No. 2 was made with the instrument described in a report published in the Archives[1]. It is important to note that regardless of the wavelength and the type of generator used, the same results were achieved within very narrow limits of error. This clearly shows that the measurement of the power absorbed by the patient as described above, is an exact quantity upon which we can rely.

Credit must be given to Kowarschik and Weisz, of the University Clinic in Vienna, for having been among the first to carry out a systematic series of measurements of power absorption under the control of the dosimeter unit recently submitted to our department at Rush Medical College for investigation. Part of their unpublished observations is incorporated in our text, a privilege for which we acknowledge our appreciation. These authors divided the range of heat sensations as experienced by patients into the following four categories:

1. The threshold value (glow-like sensation).
2. Distinct feeling of agreeable warmth.
3. Intensive heat.
4. Unbearable heat.

All tests were made at 3 minute sessions, using 130 mm. diameter electrodes with 4 cm. air spacing on both sides. The tests always started from zero level. Power input was slowly increased until a subjective heat sensation as related to the above categories was experienced by the subject. It is interesting to note that the sensation of all individuals corresponded within very narrow limits to a uniform power absorption, as controlled by the dosage unit incorporated in the short wave generator. Although temperatures of varying degrees were recorded in individuals who registered the same wattage, the subjective heat sensation was the same. Similar observations have since been duplicated by other authors, all of whom have noted that various temperature gradients are not reported by all patients in a like manner (Liebesny[7], Bierman[8]).

To obtain a clearer impression of the relationship between power absorption and the various grades of heat sensation, we have attempted to

reduce the data of Kowarschik and Weisz to a diagram (fig. 4). In this chart the abscissae show the power absorbed by the composite living tests for different applications of short wave diathermy as indicated by the various lines and legends in the diagram. For practical purposes a logarithmic scale was chosen for the abscissae as well as for the ordinates. The ordinates correspond to the various heat sensations. To obtain a certain functional relation between power absorption and heat sensation, various degrees of the heat experienced are represented in the diagram as logarithmic units.

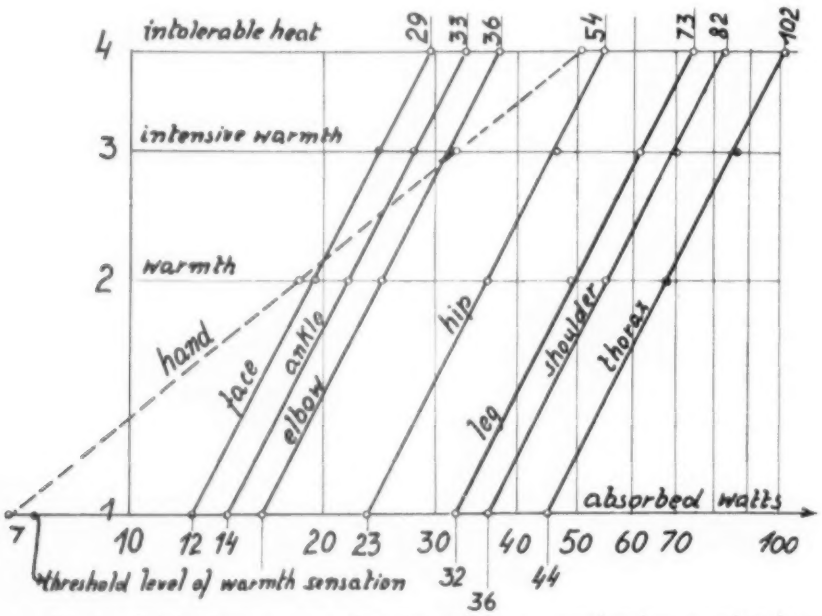


Fig. 4. — Relation between power absorption and the corresponding heat sensations in various parts of the body as measured by Kowarschik and Weisz. The abscissae represent in a logarithmic scale the power absorbed by the object under treatment at which a certain heat sensation occurs. For the heat sensations as indicated in the figure, an arbitrary scale in logarithmic units was selected as ordinates.

The choice of such a scale is merely arbitrary and has no other purpose than to provide a methodical survey of this problem. The choice of logarithmic units for the "sensation scale" was influenced by the well known fact that most of our sensations respond in a logarithmic character to the adaption of a primary action. The regularity of the sequence of the points measured is proof of its exactness. It is noted that all treated parts of the body are represented by straight lines to indicate temperature gradients, which run a fairly parallel, adequate and accurate course. By simple mathematical laws one can actually calculate how to achieve a certain grade of duplicate heat sensation even when induced from a weak energy output. One can show that the same percentage increase in power absorption is required regardless which part of the body is considered. An exception follows in relation to the hand, because one is here confronted with a lower heat sensitivity. This may perhaps be due to the fact that the hand averages a lower sensitivity against heat variations than other less exposed parts of the body. These results definitely agree with what may be anticipated from theoretical computations concerning the energy absorption under various conditions.

From a practical viewpoint it was necessary to investigate the upper and lower limits of power absorption, corresponding to the total range of heat sensations from its minimal threshold value to actual intolerance. The

plotted graph in figure 5 has been obtained from the results of the diagram in figure 4, and indicates the percentage value of the necessary increase in power tolerance to achieve the various gradients of heat sensation. This, of course, is computed from the power absorption measured at threshold heat sensation taken as unity. As is seen from this graph, the entire range of energy variation between the first heat sensation and the limit of patient's tolerance is about 1:2.5 for any given part of the body. It is further interesting to note that the higher the value of the heat, the smaller is the percentage increase in energy needed to achieve the next step of sensation. For instance, between the level of threshold and distinct warmth an increase of 50 per cent of the original power is necessary; the range between intensive and intolerable heat requires only an energy variation of about 10 per cent. This observation gives us definite direction about the minimum demands which can be introduced concerning accuracy of the device for dosage

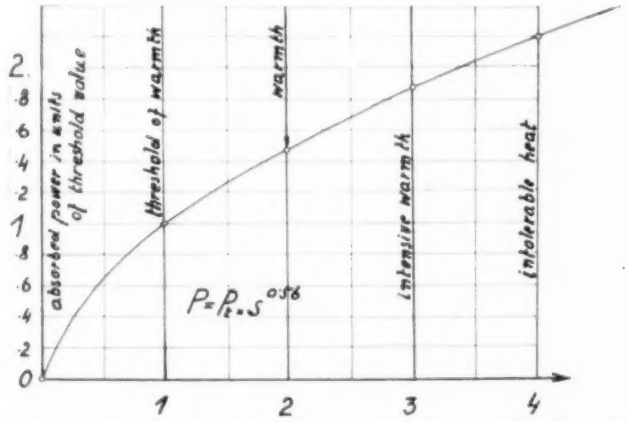


Fig. 5. — Curve taken from diagram in figure 4. The abscissae represent the various steps of heat sensation corresponding to a steady increase of power absorption from zero to maximum. If the power absorption at which the threshold of heat sensation occurs is taken as unity, the ordinates represent multiples of this value, which are necessary to obtain a given heat sensation.

control. The same holds true for the variability of the output control of a short wave therapy generator. We should have at least a leeway of approximately 7.5 per cent of the variation in the energy output of short wave generators.

The investigations of Kowarschik and Weisz have since been repeated and duplicated within a few per cent of error, and were even clinically extended by recent observations at the Physical Therapy Department of Rush Medical College of the University of Chicago. Further investigations were justified not only to confirm a long sought for method of dosage control of American made generators and electrodes, but also to widen the scope of its applicability for every conceivable type of clinical use. In the main, the measurements included both air-spaced and cuff electrodes of different diameter, in balanced and unbalanced positions, according to the most common procedures used in practice. The results of these measurements presented in figure 6, are both quantitatively and qualitatively in accord with the findings arrived at in the Vienna clinic. For purpose of clear comparison the same system was utilized for our orientation (fig. 4). For a better understanding of the applied technic details of electrode size and positions are listed in table 2. The results of the measurements with cuff electrodes confirmed the theoretical assumption that there is no material difference in wattage absorption between that of air spaced and cuff electrodes. For instance, one may observe that the dash-dotted lines of the

cuff electrodes (fig. 6) maintain a nearly parallel course with the non-interrupted lines of the corresponding air-spaced electrodes. There is only a slight difference in the amount of the power absorbed corresponding to the threshold value of heat sensation and perhaps a more distinct response to heat power variation. (The slope of the dotted lines is higher than that of

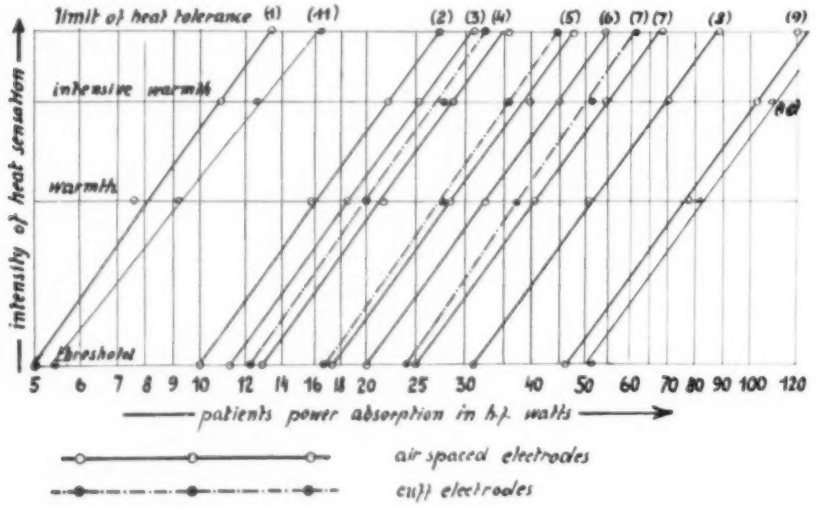

limit of heat tolerance
(1) (11) (2) (3) (4) (5) (6) (7) (7) (8) (9)
intensive warmth
warmth
threshold
intensity of heat sensation
5 6 7 8 9 10 12 14 16 18 20 25 30 40 50 60 70 80 90 100 120
patients power absorption in h.f. watts
air spaced electrodes
cuff electrodes

Fig. 6. — Relation between power absorption in the various parts of the body and the corresponding heat sensations. Measurements by Kobak and Mittelmann. For details in electrode application see table 2.

the full lines.) This observation is perhaps explainable by the lack of cooling at the surface when cuff electrodes are used.

TABLE 2. —*Description of Technic Used in Measurements of Power Absorption*

No.	Object	Electrodes	Application
1	Face	80 mm. diam.	3 cms. distance on both sides parallel to cheek
2	Face	130 mm. diam.	4 cms. distance on both sides parallel to cheek
3	Skull	130 mm. diam.	4 cms. distance antero-posterior parallel
4	Elbow at 90°	80 mm. diam.	4 cms. distance electrodes below and above elbow
5	Arm and forearm	80 mm. diam.	5 cms. distance electrodes at wrist and shoulder
6	Elbow-chest	130 mm. diam.	6 cms. distance electrodes at elbows
7	Leg	130 mm. diam.	5 cms. distance electrodes above and below knee
8	Shoulder	80 mm. diam.	3 cms. distance electrodes
9	Shoulder	130 mm. diam.	4 cms. distance electrodes antero-posterior
10	Knees-abdomen	130 mm. diam.	5 cms. distance electrodes at knee joints
11	Finger and toes	80 mm. diam.	4 cms. distance fingers between electrodes
12	Abdomen	130 mm. diam.	4 cms. distance results approximates Thorax in figure 4

Of special interest are the measurements in experiment 10. With the patient in the sitting position and thighs held apart at an angle of 30 degrees, air-spaced electrodes were applied externo-laterally to both knees at 7.5 cm. distance. The first subjective threshold sensation indicated that it began at the region of the knees and radiated toward the soles. The second gradient became associated with a distinct feeling of pleasant heat in the knees, the upper thighs, the bladder and even the abdomen. The third or heat tolerance limit was usually accompanied by complaint of unbearable heat in the bladder and abdomen. Phantom experiments with bread models were conducted at the same time in order to determine a parallelism or uniformity

of the experiment on laboratory and clinical material (see Appendix). Similar observations were made as shown in test No. 6. The first heat sensation was registered in the areas underneath the electrodes, but with increase of power absorption a distinct sense of warmth was radiated over the entire arm, the axilla, shoulder and chest wall.

To answer the inevitable question whether as advocated in conventional diathermy, one should slowly raise the maximum intake of absorbed power by means of several steps or promptly introduce the maximum load, both methods were tried. In both instances it was found that the physiologic accommodation of the temperature reflex could only absorb the same load of energy, irrespective whether introduced in terms of maximum wattage or by graduated steps. For instance, if 50 watts were applied to a surface in the period of a few seconds or fractionally approached in several minutes, the response would be a sensation of unbearable heat only when the wattage registered the above indicated number. This observation is rather surprising, for one might expect that immediate absorption of a wattage load would require smaller dosage than when this followed in a manner to permit the extra accommodation of sensation. Results of investigations related to this problem will be published in an early communication.

Appendix

The principle of effective measurement of power absorption in the patient's circuit is based on some sort of damping calculation, or a determination of the various loss resistances. By introducing the body between the electrodes, a loss resistance is added to the initial ones of the circuit, the magnitude of which depends upon the area of the electrodes, the factor of air spacing and not least, upon the volume of the mass introduced. For a given object the extent of the additional loss resistance will depend upon the coupling capacities as represented by those of the electrodes against the object.

We assume that in our schematic idealization of the circuit of a short wave therapy generator all losses are associated with resistances parallel to the terminals of the oscillatory circuits. It is known from high frequency physics that for this condition the resonant voltages measured at the terminals of the circuit will be proportionate to the resistances which are in parallel to the terminals. Indicating the equivalent loss resistance of the unloaded circuit (no object is introduced between the electrodes) by R_1, the resonant voltage e_1 across the patient's circuit is given by the equation

$$e_1 = k. R_1$$

where k is a factor of comparative relation. Introducing the object, a resistance is switched in parallel to the resistance, and provided that the primary voltage of excitation is the same as before, the resonant voltage e_2 will be proportionate to the resulting resistance of the parallel combination

$$e_2 = K. \frac{R_1 \cdot R_2}{R_1 + R_2}$$

From these two equations the value of the equivalent parallel resistance — representing the introduced losses by the patient — is easily evaluated as

$$R_2 = R_1 \cdot \frac{e_2}{e_1 - e_2}$$

If by some means the primary exciting voltage is kept constant, so that for the unloaded circuit with the loss resistance R_1 the resonant voltage always will be e_1, the equivalent parallel resistance denoting the losses is introduced by the patient is delineated as merely a function of e_2. In other words, under the given conditions the resonant voltage across the loaded patient circuit depends only upon the equivalent patient's resistance.

The power absorption corresponding to the additional load by the patient alone, is then represented by the well known formula $P = E^2 \frac{1}{R_2}$ if E shows the magnitude of the high frequency voltage across the circuit under working conditions.

Referring back to figure 1, the voltage E is measured by means of a thermocouple Th, and a galvanometer G. The thermocouple Th is connected to the oscillatory circuit by

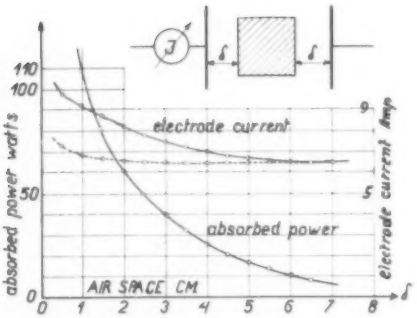


Fig. 7. — Comparison between current and power absorption measurements. Current and power are measured simultaneously for various values of air spacing between object and electrodes.

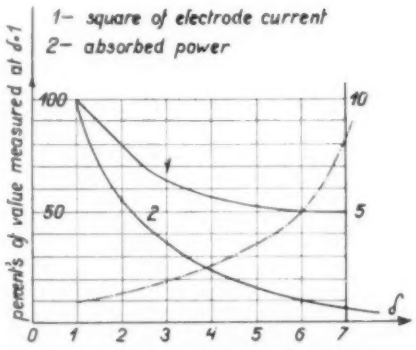


Fig. 8. — Comparison between the percentage decrease of power with increasing air space as taken from measurements in figure 7. The current measurements indicate a higher power absorption than can actually be obtained.

means of two small capacities C^1. The deflection of the galvanometer G is proportionate to the square of the voltage E and to the sensitivity of the meter. If, therefore, by some means we can arrange that the sensitivity of the galvanometer should always be proportionate to the value $\frac{1}{R_2}$, the readings of the galvanometer G will indicate the actual value of the power absorbed by the body as given by the above equation. This is very easily

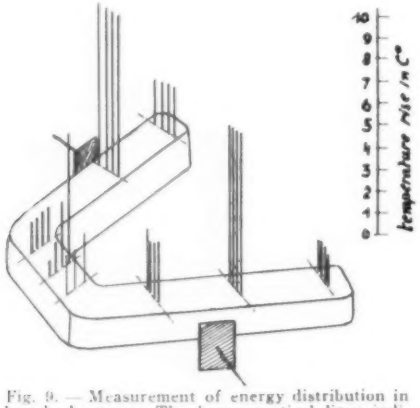


Fig. 9. — Measurement of energy distribution in bread phantoms. The heavy vertical lines indicate the differences between initial and final temperature as shown by a differential thermometer.

accomplished by means of a calibrated resistance R_{sh}, which is connected in parallel to the galvanometer G. The dial of this variable resistance is calibrated in such a way that for every value of the resonant voltage e_2 corresponding to the actual value of the equivalent patient resistance, there is a similarly marked dial setting, which adjusts the sensitivity of the galvanometer proportionate to the actual value of $\frac{1}{R_2}$. The procedure in which dosage measurements are performed with this instrument is very similar to that already described by one of us[1].

As already shown by experiment, for a given pair of electrodes the reading of e_1 is nearly independent of the electrode distance. It is therefore sufficient to tune the unloaded circuit with any positions of the electrodes and make the final adjustment after the introduction of the patient. Then the circuit is again tuned and we obtain the value of e_2. Setting the dial of the resistance R_{sh} to the corresponding mark, our meter is calibrated as a direct reading wattmeter for the actual case under treatment.

It should be remembered that the actual value of the damping and therefore that of the equivalent patient's resistance which determines the value of the power absorbed, is greatly influenced by the capacities of the electrodes and object against ground. The same holds true concerning the voltage distribution across the electrodes. This is one of the main reasons why it is impossible to obtain a generally valid relation between the voltage

as measured across the electrodes and the power absorbed by the patient. Power absorption is a rather complicated function not solely of the voltage, but depends on wavelength, capacity and phase shift between voltage and current. Methods, therefore, based on a pure voltage measurement must fail, if conditions other than those prevailing during the calibration of the instrument (relation of electrodes and air spacing) are considered.

For this very same reason all methods using some other form of current measurement must fail. Referring to the discussion on dosage measurement in the current March issue of the ARCHIVES[1], figures 7 and 8 may be of particular interest in their graphic method to clear up certain objections advanced. In figure 7, the electrode current and the absorbed power in the calorimetric phantom between the electrodes are plotted against increasing air space. The dotted line indicates the electrode current when the object is removed. We have to assume that the power is proportionate to the square of the current. To get a common base of comparison in figure 8 the percentage decrease of the square of the current measured and the percentage decrease of the power absorbed as measured by calorimetric methods, are plotted against the distance between object and electrodes. For both current and power the value as computed at a distance of 1 cm. was taken as the initial value of 100 per cent. The dash-dotted line indicates the ratio between the percentage value as given by curves 1 and 2, respectively. The wider the air space, the greater the error made by an assumed correct current measurement. These results are to be expected from a theoretic viewpoint and are satisfactorily explained (fig. 7) by the decreasing difference between the electrode current with and without an object in relation to the electrodes.

For the better understanding of what may be expected of heat distribution, experiments were made with bread phantoms with the aim of obtaining some quantitative information or guidance about energy dispersion when dealing with more complicated electrode arrangements in the living subject. Phantoms and electrode positions were selected as illustrated in figure 9. This study is typical of the in vitro method used for measurements. From clinical experience it is well known that with similar arrangements, heat concentration may be achieved in parts that are in symmetrical position with the electrodes. Such a technic is often used in treating bladder and abdominal diseases. The heavy lines indicate the measured temperature differences at the various points of the phantom. All temperatures were checked at the center of the model. The distribution of energy was found to be proportionate to the values of temperature differences and in accord with theoretical computations. The highest temperature differences were reached in the regions near the electrodes and at symmetrical points. By election of certain electrode positions along the phantom, different types of energy pathways could be achieved. In general heating was found to be more uniform when electrodes were fixed close to the end of each side of this object. Accordingly, the results are in agreement with the subjective statement of the patients as mentioned with the tests described in the first part of this paper.

Conclusions

1. A new method of simplified and reliable dosage control in short wave diathermy is presented.

2. The dosimeter readings were confirmed by phantom experiments with an average accuracy of about 5 per cent. The indications of the instrument are independent of the size of electrodes and their positions, both balanced and unbalanced.

3. The measurements of power absorption of the patient can be reproduced with adequate accuracy, facilitating its clinical dosage.

4. Clinical experiments concerning the relation between subjective heat sensations and values of the absorbed power as measured by this device were repeatedly reproduced with uniformity.

5. With this method of dosage control in short wave diathermy clinical values were established for the first time, which may be regarded as essential to exact therapy, insuring against untoward effects by improper and empiric administrations.

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ATHERMIC SHORT WAVE THERAPY *

P. LIEBESNY, M.D.

NEW YORK

The discovery of diathermy has led to the impression that the high frequency current is biologically effective only through the heat which it may produce, and not to any particular specific electric effects on living tissues, characteristic of other kinds of currents. In other words, diathermy was thought to be biologically ineffective in doses which produce no measurable heat. This opinion predominates especially with regard to short waves, and it is therefore astonishing that certain authors have declared that they were able to obtain the safest therapeutic effects with diathermy at a dosage that could not possibly lead to tissue heating.

It can hardly be denied that the galvanic or the alternating current of low frequency can be applied and used successfully for therapeutic purposes only in such small doses which do not create definite tissue heating. Nevertheless, clearly defined specific electric effects of direct currents have been established by physiologic studies. As an illustration I refer to galvanotaxis of leukocytes, described by Dineur in 1891, proving that normal leukocytes move to the anode, while those of inflamed tissue move to the cathode.

In 1932 Monguio of the laboratory of the Austrian scientist Scheminzky, was able to report that reversion from cathodal to anodal galvanotaxis depends on the physiologic state, consequently on the internal conditions of the cell. This behavior is analogous to the reaction characteristic of various microorganisms in the short wave condensor field, which we have described on many occasions. With the alternating current, too, specific electrical effects on living tissues have long been known. They were first observed by Statkewitsch and later minutely examined by Scheminzky and his collaborators and described, respectively, as oscillotaxis and oscillotropism.

With regard to higher frequencies Muth observed for the first time in 1927 that in the alternating current field of 2.10^4-2.10^6 pearl chains are formed in fat emulsions, i. e., the fat globules arrange themselves in such a way that the line of communication of their central points is parallel with the field. According to Muth's opinion on the formation of these pearl chains the action is associated with a minimum value for the field power, below which no chains are formed any longer, and approximately in proportion to frequency. According to this theory it was to be expected that the formation of chains should occur also in the low frequency current if very low energies were used, and I was able to confirm this fact in the investigations

* After a paper read before the International Congress for Short Waves, Vienna, 1937.

which I undertook together with Pace. According to Muth's theory, however, it should be possible to obtain such pearl chains in emulsions in the ultrashort wave field only by applying excessivly high field energies. But as high energies in the short wave field tend to heat emulsions to such a degree that the generated heat currents would at first prevent pearl chain formation, and as, if the energies are still higher, the fat emulsion would begin to boil, it was first of all to be expected that in the ultrashort wave field the specific electric phenomenon of this pearl chain formation would be impossible.

We are indebted to Krasny-Ergen for the proof that the minimum value for the formation of such pearl chains does not depend on the frequency of alternations and that consequently the formation of these pearl chains can also be effected in the ultrashort wave field if relatively weak energies are used. These facts were proved by Krasny-Ergen by theoretic calculations and laboratory experiments.

In a film prepared in collaboration with Pace, this process was fixed in fat emulsions (diluted milk). It was also demonstrated that the same phenomenon can be seen in the ultrashort wave field, even in yeast emulsions and in blood. Figures 1a and 1b are sections taken from the above mentioned film and clearly show the influence of the ultrashort wave field on fat emulsions (milk), while figures 2a and 2b depict the specific

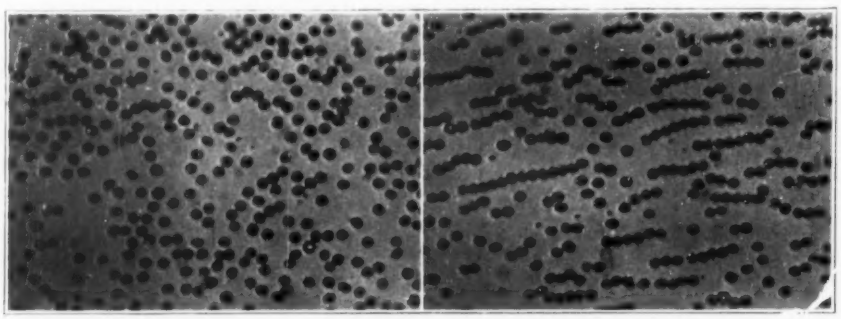

Fig. 1a, and 1b. — Before and after short wave irradiation on emulsion.

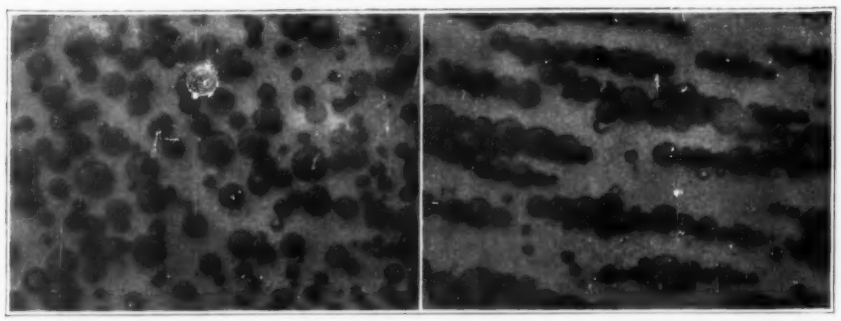

Fig. 2a, and 2b. — Before and after short wave irradiation on human blood.

influence of the ultrashort wave field on human blood. The film shows unmistakably that there are also in the short wave field specific electric effects which are capable of influencing the degree of dispersion of suspended particles, the speed of sedimentation, the viscosity and — by certain physical influence described by Krasny-Ergen* — the capillary powers in an

* International Congress for Short Waves, Vienna, 1937, Transactions p. 183; Mechanische Wirkungen der Kurzwellen by Krasny-Ergen, Stockholm. Hochfrequenztechnik und Elektroakustik **48**: 126, 1936. Ibid. **49**:195, 1937.

emulsion affecting the suspended particles. The above referred specific electric effect of the alternating current field is, as we have shown, independent of frequency and consequently also peculiar to the short wave field.

It is generally acknowledged that the heating effects of short waves on living tissues are effective even in places protected from long waves by insulating materials. Consequently there is no reason to suppose that this insulation should admit the heating effects of the short waves and should, on the other hand, form an impenetrable wall against the specific electric effects of the same fields.

Although I will not assert on the strength of the above mentioned investigations that the non-thermic effects of the ultrashort wave field are fully explained, I venture to express the hope that those authors who are now of opinion that high frequency currents in general and short waves in particular can be biologically effective only by means of their heat effects, will modify their conclusion.

Therapeutic Results

For therapeutic purposes it can no longer be seriously doubted that we can obtain healing effects in many diseases with high frequency currents in general and short and ultrashort waves in particular, without producing tissue heating. By means of case reports and photographs I was able to demonstrate in numerous publications and particularly in my book "Kurz-und Ultrakurzwellen" the healing effects of short waves on inflammations with the lowest possible athermic doses.

At the International Congress for Short Waves in Vienna, 1937, I showed again by clinical demonstrations the healing effects of short waves in the mode of treatment and dosage which I have recommended in cases of facial furuncle, carbuncle, empyema of maxillary cavities and tuberculosis.

It is particularly important strictly to avoid in the treatment of tuberculosis a dosage that may lead to heating effects in tissues. At the same Congress, Schliephake pointed out this very fact when he reported that he had obtained favorable effects in cases of tuberculosis of the throat with minimal doses only.

I should like to stress that like myself Schliephake strongly avoids any higher doses in acute inflammation. He states (see p. 232 of the transactions): "The general principle is: the acuter the process, the shorter the time of irradiation and the wavelength, and the smaller the dose."

I should also like to refer to a paper recently published by Gutzeit and Küchlin of the Medical University Clinic of Breslau. These two authors observed a transitory augmentation of the blood sedimentation rate in dental infections provoked by short waves. In thermic doses an increase was observed after 10 minutes' irradiation of a tooth if affected by an active process, but when an inactive area was radiated this increase of the blood sedimentation rate did not appear. Gutzeit and Küchlin recommended their method for differential diagnosis of active and inactive processes in dental affections and their general sequelae. It cannot be decided, according to the opinion of these authors, whether this short wave in thermic doses causes toxins, or whether the products of decomposition of albumin of a non-bacterial kind from the activated inflamed area have such an influence on the blood sedimentation rate. In any case I think I can refer to the fact that precisely these investigations of Gutzeit and Küchlin have unmistakably proved that inflamed areas show signs of provocation when irradiated by short waves in thermic doses. They support the claim which I have always maintained that in an acute inflammatory process doses which may produce tissue heating must absolutely be avoided.

At our department we have made observations of particular interest in the treatment of suppuration of the middle ear, accounts of which were presented to the Congress by Meller, Löwy and Fuchs. It appeared that in patients who had suffered from suppuration for years after a radical operation, the cavity resulting was dried up by short wave treatment in many instances, while in other's the granulations disappeared without recurrence. Among twenty of these patients who were sent to us from Professor Neumann's clinic, and who were submitted to short wave treatment, only one proved refractory. We were, however, not successful in spite of applying the same method of irradiation and the same doses in patients with chronic otitis who had not been radically operated.

It is highly interesting for radiation therapy in general that these similar forms of diseases respond so differently to irradiations of the same kind. I cannot say if the same result can be obtained by short waves in thermic doses in chronic otitis, such as we had been able to observe in chronic suppuration of the middle ear after radical operations, for I refuse to give short wave treatment of the head in thermic doses as long as we have no objective dosimetry to guide and regulate our therapy in these important and delicate structures.

Skin temperatures showed that it is not possible to rely on the temperature sensations which patients subjectively, experience during the short wave irradiation. In patients suffering from chronic arthritis and whom we treated with thermic doses in the short wave field, we could often state that they did not feel an increase of skin temperature of 3-4 C.

The result of skin temperatures taken during long wave diathermy with contact electrodes was that many persons felt a rise of skin temperature of 3-8 C. as still "agreeably warm." A few others and among them myself, felt with diathermy of the lower arm a rise of skin temperature of 10 C. as "tolerably warm."

These experiments show that the subjective warmth sensation of patients does not afford a reliable guide of the heating effects brought about in tissues by thermic doses. On the other hand we were able to demonstrate with athermic short wave treatment, by measuring skin temperature with the thermoelement of Pfleiderer and Büttner that in the treatment of acute inflammatory affections with the uniterminal method, no increase of skin temperature is effected, while in the treatment of the above mentioned pathologic cases with the biterminal method we were occasionally able to measure an increase of skin temperature of 0.5-1 C. In this way we were able to assert on experimental evidence, that with our athermic method no heating of biologic significance is effected in the deeper strata of the tissues. In connection with these statements I may refer to the fact that we were able to obtain remarkable results with a short wave apparatus of relatively low energy (maximal effect about 60 watt in the secondary circuit) with a wavelength of 3 m. in a case of suppurative ophthalmia as reported to the Vienna Congress by Hausmann, Rieger and Rabinowitsch.

Conclusions

On the basis of the experiments of Krasny-Ergen, we were able to demonstrate that short and ultrashort waves as well as all other kinds of currents possess specific electric effects. We were able to show on a rich clinical material that short waves in athermic doses are a very reliable remedy in acute suppuration and also some forms of chronic inflammation.

In the interest of suffering mankind I feel obliged to pursue in short

wave therapy the course which I have taken up in the beginning of 1932. In doing so I can state with satisfaction that many authors, Cahen and Saidmann, Raab, Schliephake, Urbach and Weissenberg among others, have already recognized, like myself, that short waves in small doses afford the highest results in many affections, though, of course, not in all.

I must, however, admit that calling the method "athermic" or "low intensity short-wave treatment" is not satisfactory, as these terms do not enable the author to give the general practitioner a precise and definite notion of the method of treatment when he uses different types of apparatus. I hope that objective dosimetry will soon allow every author to prescribe clearly and unmistakably the optimal doses of short waves that are, according to his experience, suited to the treatment of different diseases.

EFFECT OF THE ELLIOTT TREATMENT ON THE NASAL MEMBRANE *

FRANK L. BRYANT, M.D.
MINNEAPOLIS

Local therapy of acute sinus infection generally consists of two methods. The one more often employed has for its purpose the promotion of drainage, while the other aims at lessening the infection by augmenting the protective and defensive mechanisms of the body. Not of least importance in either is the protection and speedy restoration to normal of the nasal and paranasal tissues. This must be kept in mind for its future efficiency and economy.

A study was made of the effect of local fever therapy with the Elliott apparatus on the membranes of the nose, the ciliary activity, and the nasal secretion. Before the findings and conclusions are reported a brief comparison of the rationale of the two methods merits consideration.

As yet we have no specific remedy for each of the bacterial invaders which may cause acute sinusitis. Until that time comes we must, of necessity, be content to treat the patient in one of two ways. In the one method which emphasizes the promotion of drainage, secondary importance is given to the excitant of the altered physiology. In other words, the body is aided in getting rid of that which the infecting agent caused rather than helping it in eliminating the infecting agent.

The rhinologist who subscribes to this plan usually resorts to one of the group of drugs known as vasoconstrictors. Fortunately many are not employing the more drastic ones or those of stronger concentrations in their endeavor to aid the patient.

A summary of the action caused by vasoconstrictors on the nasal mucous membranes and their cilia is given below.[1, 2]

Cocaine: A 1 to 5 per cent solution causes contraction of the cavernous vessels of the turbinates without producing any apparent change of the surface capillaries. A 20 per cent solution causes a very marked effect on the cavernous tissue and slight blanching of the surface vessels.

Adrenalin: A 1:1000 solution induces marked anemia of the surface vessels and contraction of the cavernous ones.

* Read at the Sixteenth Annual Session of the American Congress of Physical Therapy, Cincinnati, September 21, 1937.

Both cocaine and adrenalin have also been shown to inhibit the action of the cilia of the nasal mucous membrane.

Ephedrin: A 3 per cent solution causes vasoconstriction of both cavernous and surface vessels. It is asserted that no depression of ciliary activity takes place.

Numerous synthetic preparations produce varying degrees of vasoconstriction. Preparations with 2 per cent zinc sulphate or ½ per cent silver nitrate are detrimental to ciliary activity.

It is admitted that certain vasoconstrictors in weak solutions do not harm ciliary activity while at the same time promoting drainage. One may properly ask if, in the presence of adjacent infection, vasoconstriction does not increase susceptibility, and decrease resistance of the yet uninfected tissues.

The rhinologist knows that when a definite and acute inflammatory condition exists in the nose and paranasal sinuses, the effect of the vasoconstrictors is in direct contrast to the amount of existing engorgement. In the severe grades of acute sinusitis mild vasoconstrictors have either a very fleeting or no effect. The stronger ones obviously would be harmful.

The first method of treatment, then, is one to produce relative ischemia for the purpose of promoting drainage. It temporarily retards the increased flow of blood while the débris is removed. The second plan of treatment is one of vasodilatation. This method could be overdone just as vasoconstrictor therapy is abused when strong and drastic agents are employed.

Acute sinusitis is characterized by redness and swelling of the nasal and paranasal mucous membrane and subsequent exudation of mucopus. Three distinct phenomena occur; namely, alteration of tissue, exudative or vascular reaction, and proliferation.[3]

The alteration of tissue may be looked upon as the first and unsuccessful part of the battle. The invaders have wrought damage. The dominant factor is the second phase. It is the answer of the body to the invader. Changes in the blood vessels and capillaries, their contents, and perivascular structures are its features. The dilatation of the blood vessels releases into the tissue an exudate similar to the blood plasma. Mobilization of leukocytes take place. The protective substances and antibodies of the blood are also believed to be conveyed in the plasma. It is held, in addition, that the exudate dilutes and flushes the infective agent.

One may draw this conclusion from the study of the inflammatory process. Elimination of the infective agent is the primary task of the body, and as long as the inciting factor is present, exudate will be formed. Removal or drainage of the exudate is, of course, important. Any accumulation interferes with the normal protective processes. Nature herself is able to do this in a great measure. By the presence of leuko-protease enzyme in the polymorphonuclear leukocytes and the lympho-protease enzyme in the large mono-nuclear cells, an entire purulent exudate is capable of undergoing autolysis.[4, 5]

With a large accumulation of a purulent exudate in a sinus, extreme toxicity and high fever become manifest. Obviously this requires some form of emergency drainage by surgical intervention, especially if extension beyond normal confines is imminent. One may interpret such a condition as a breakdown of the normal drainage mechanism — both by the blood and the natural ostia. This, however, is the exception and not the rule.

Studies were made on patients with acute sinus infection to determine (1) the gross appearance of the membrane, (2) the ciliary activity, and (3) the character of the secretion.

Effect of Elliott Treatment

Seven non-allergic individuals who had neither nose nor throat complaints and who had no clinical evidence of sinus infection were each given one Elliott treatment. Six were treated bilaterally, one unilaterally. Of the bilateral group one was treated for fifteen minutes at 120 F. After removal of the applicators only a small amount of thin clear mucus was observed in the nose, no more than if the patient had sneezed two or three times. Three were treated for sixty minutes at 120 F. After the treatment a considerable increase in the amount of mucus was observed. Most of it was quite clear, although some opaque areas were noted. Smears of this revealed polymorphonuclear leukocytes. The turbinates were of a diffuse, but not angry red color. Two patients were treated for sixty minutes at 132 F. The same amount of mucus observed in the above group of three was seen on rhinoscopic examination. There was some dried exudate on the exposed portion of the applicators. The middle and inferior turbinates in all were more red and somewhat increased in size. All experienced some stuffiness but no obstruction even before removal of the mucus by cannula suction. The two individuals treated at 132 F. seemed to notice it somewhat more. The condition in all did not persist long. In the seventh individual who was treated on one side for 45 minutes at 120 F. the findings on the treated side were essentially the same as those treated on both sides in a similar way.

Ciliary activity was studied by the droplet of India ink method.[6] The one treated for fifteen minutes showed no decrease or increase in the motility. In the three individuals treated for 60 minutes at 120 F. the India ink particles were very active. This was undoubtedly due to the increased amount of mucus. After removal of the ink and mucus by cannula or mass suction a droplet was again applied. In one, no increase over the normal could be seen. In two, there was some increase. The amount of mucus may still have been a factor. In the two persons who were treated for sixty minutes at 132 F. the ciliary activity was not increased over that observed in those treated for sixty minutes at 120 F. One would think it should be lessened, but this was not observed. Here, too, the mucous secretion probably was the determining factor. The individuals were seen on the first or second day after the treatments. None had any complaint.

The observations made on the normal individuals admittedly were not extensive, but it may at least be concluded that the treatment did not inhibit ciliary activity and did increase mucous secretion.

Further observations along these lines are being made to definitely establish these conclusions.

Rhinoscopic examination of a patient with acute sinusitis revealed turbinates and angry red mucous membrane. Dependent upon the extent of the infection a variable amount of mucus and mucopus was observed in the nasal cavity.

Removal of any exudate was made as completely as possible by cannula suction. A small droplet of India ink was placed on the mesial portion of the swelled middle turbinate and also on its inferior aspect near the middle meatus. Almost without exception the first droplet moved little, if at all. The droplet in the region of the middle meatus moved, but not as rapidly as normal — four to six millimeters per minute.

If the middle and inferior turbinates were unusually swelled and red, as they often were on the first few days of observation, a minimal amount of activity of the cilia was present as evidenced by the little motility of the ink.

The Elliott treatment was given from 45 to 60 minutes at 120 F. During the first fifteen to thirty minutes the patients experienced little post-nasal accumulation. In the last fifteen to thirty minutes secretion was felt by the patients in the nasopharynx. This was especially marked in the patients who had an acute pansinusitis.

At the completion of the treatment upon withdrawal of the applicators they were found to be covered with rather thick mucopus. However, later less discharge was both observed and experienced. The exudate was removed as thoroughly as possible by mass or cannula suction. Often veritable masses of the purulent material could be seen flowing through the glass cannula, though before the treatment the nasal cavity had appeared to be free.

A droplet of ink was again placed in the same areas as before treatment. In the majority of the patients more activity could be observed. In some individuals especially toward the end of the series of treatments more than normal activity was noted. This I interpreted, as before, as due to the flow of mucus.

During one treatment in each of three patients the temperature was purposely kept at 135 F. for over thirty minutes. Each patient remarked that the applicators "seemed too warm." Observation at the end of the treatment appeared to verify this. The exposed part of the applicator was covered with dried mucopus, as was that portion just within the nasal vestibule. There was also less discharge to be removed. At the end of the treatment the droplet of ink showed no appreciable change in the rate of motility as compared to that seen before the treatment. Two patients remarked that they had nasal stuffiness for the rest of that day.

Proetz[7] found that ciliary activity ceases at a temperature over 109.4 F. (43 C.). The intranasal temperature of the last two patients was, of course, over that limit.

It is now my practice to use a temperature of from 118 F. to 120 F. for the first part of the series of treatments and never over 125 F. as the nasal mucous membrane becomes more normal.

Results similar to those previously reported by me[8] were obtained in a series of seventeen patients who had signs and symptoms of acute sinusitis. No patient who had a surgical emergency was included or subjected to this type of treatment. Similarly no patient upon whom treatment was started developed a surgical emergency.

Summary and Conclusions

The rationale of vasoconstriction and vasodilatation therapy is discussed.

Elliott nasal therapy in proper application increases mucous secretion in the normal nose; it does not inhibit ciliary activity.

In patients with acute sinusitis, uncomplicated and nonsurgical in nature, the Elliott nasal therapy promotes the flow of exudate by the natural ostia and undoubtedly by the circulation itself. Ciliary activity is increased in many individuals, and in none could it be found to be inhibited when given at proper temperature.

1600 West Lake Street.

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ELLIOTT THERAPY IN OPHTHALMOLOGY *

M. S. UDELF, M.D.

CLEVELAND, OHIO

Within the short span of two years, the application of the Elliott therapy in the management of ocular entities has attained a useful and apparently valuable position. The first important work of this nature was initiated in 1935 at the Episcopal Eye, Ear and Throat Hospital in Washington, D. C. At that institution, a consecutive series of five hundred cases was treated on an experimental basis. The results secured were so exceedingly satisfactory that the therapy has been instituted as a routine measure.

It is not my intention to present the Elliott technic of treatment as a cure-all. But I maintain that it is deserving of recognition as an adjunct in the treatment of acute iritis, corneal ulcers, purulent conjunctivitis, hordeolum, ecchymosis of the lids and hyphema. More recent work has shown its applicability in glaucoma.

Heat is a recognized and accepted therapeutic agent in the conditions enumerated above. The Elliott machine with the improvised eye applicator affords a convenient method of utilizing and applying heat. It also has the distinct advantage of a vibratory massaging effect through the continuous flow of the water that is both soothing and helpful. The circulation is stimulated. Nutrition to the diseased area is increased. The elimination of waste products is promoted and restitution is augmented.

In corneal ulcers the Elliott therapy is particularly suitable for use in the office. Heat is notably important in the therapy of these cases. Immobilization of the organ involved by patching is necessary and it is not, for obvious reasons, wise to permit the patient to change patches at home for the purpose of applying hot compresses. Daily utilization of the Elliott technic in the office renders a genuine service with satisfaction to the patient.

In cases of styes or chalazia, the physician can give beneficial treatment with this machine. Too frequently patients are sent home with advice to apply hot compresses, when a single Elliott treatment almost regularly effects drainage with rapid control of the infection.

Hot compresses can be used in the office, but the disadvantages and inconveniences render the Elliott apparatus a welcome measure. In the employment of hot compresses, the heating of the solution requires almost constant attention. Boiling over is not unknown. The temperature is not easily managed or maintained. Burns are definitely a hazard prone to occur. The moisture is not requisite to convalescence and is unsuited to the comfort of the subject. With the Elliott technic all this is avoided. The necessary treatment is accomplished with relative ease. Constant vigilance is not necessary. It is sanitary. The patient keenly appreciates the soothing and comforting effects. The majority of them actually become relaxed under its soothing influence. Finally, in addition

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to avoiding all the hazards and inconveniences of hot compresses, there is the added attribute of the massaging pressure effect.

The factor of massaging recently had its trial in a number of cases of glaucoma where this and heat are important. Favorable results have been observed to date. The machine when in use ordinarily registers a pressure of three pounds. In all these cases, the pressure, and therefore the massaging effect, was increased by partially constricting the outlet tube. This mechanical motion can be felt by the patient and is most often well tolerated. Massaging with the fingers has been employed in the past with certain results when properly employed. However, most patients themselves do not seem to be able to accomplish this properly. The Elliott machine certainly administers this quasi-massage in a rhythmic fashion.

The manner of applying the applicator is simple and easy. For purpose of sanitation and protection, a single thickness of gauze is wrapped around the deflated applicator. It is then applied over the organ to be treated, where it is retained in place by narrow strips of adhesive plaster. The pressure is then gradually turned on, filling the applicator under the restraint of the adhesive strips. In this way, the most is made of the pressure exerted and its massaging effect. In all instances the temperature gauge registered 135 F. before starting treatment. Usually a drop of approximately three to five degrees occurs commensurate with the distension of the applicator. Starting from this point the temperature was slowly elevated to a desirable maximum. The latter was determined by the subjective guidance of the patients. Most often they are able to tolerate a temperature level of 140 F. The time of each treatment is variable and likewise dependent upon individual reaction. The minimum period is fifteen minutes, while the majority of the patients tolerate the treatment for one-half to one hour. There has been no single instance of a burn since the inception of this work.

311 Osborn Bldg.

Discussion of Papers by Drs. F. L. Bryant, and M. S. Udelf

Dr. L. J. Silvers (New York): It is unfortunate that time did not permit Dr. Bryant to continue with his detailed study of "Leukocytic Response" to local fever therapy. It seems to me that a clarification of the histologic response to all forms of deep heat penetration in the nose and throat would therefore be most pertinent.

The essayist aptly notes that the rhinologist attempts primarily to establish ventilation and drainage either by surgical or temporarily by pharmacologic means, and treats secondarily the all important problem of physiologic response to a local focus of infection. The establishment of proper ventilation and drainage is the *sine qua non* of success in any type of sinus infection. However, in the majority of acute sinus infections radical surgery is as a rule contraindicated. Optimal heat production within the tissues as shown by Dr. Bryant proved sufficient to increase ciliary activity and mucus flow in all acute cases, leaving solely the chronic sinus cases to radical surgery. In my own experience even the recalcitrant chronic case will respond to conservative fever therapy once ventilation and drainage have been established. Electrosurgical shrinkage of the turbinates and sinus irrigation preferably through the natural ostia followed by Elliott or ultrashort wave therapy is productive of excellent results in the difficult long standing cases. Cooperation of the patient is of course essential since treatment is generally prolonged and follow-up through the four seasons of the year is essential to check each new exacerbation. A follow-up of one year, quickly eradicating each fresh infection as it occurs has completely changed a thick, opaque mucosa to one that no longer discharges excessively and is normal to x-ray and transillumination.

The cellular response to the various agents employed in rhinolaryngologic physical therapy is a feature of prime importance. Raising the tissue temperature high enough to either attenuate or destroy pathologic organisms, will produce a vaccine-like reaction commensurate with the potency of the invading bacteria. A mobilization of polymorphonuclear leukocytes and large mononuclear lymphocytes provides the means by which nature rids us of infection. The destruction of myriads of bacteria in situ is followed by the absorption of their endproducts and the familiar autogenous vaccine reaction. The "sanitary squad" of the

circulatory system is present in the exudate as a product of the second stage of inflammation. The plasma cells include the reticular endothelial cell or so-called reticulocyte. It is the phagocytic and proteolytic action of this cell that aids nature's efforts at curbing the extension of infection.

The definite increase in antibody production is manifested by the mobilization of all the phagocytic plasma cells. Heating tissue to a bacterostatic level sets the wheels of "immunity response" into motion and thus affords a marked augmentation of nature's response to bacterial invasion. Any conservative means at our disposal to enhance this response is therefore most salutary. The Elliott treatment of paranasal affections as applied by Dr. Bryant must be welcomed as an asset in rhinolaryngology.

Dr. Louis A. Witzeman (Akron, Ohio): I would like to ask Dr. Udelf what the advantages of the Elliott treatment are over that of the small electric eye pad, outside of that of massage. I can readily see the advantage it would have over the hot applications, as it is giving a more continuous temperature.

Dr. Carl J. Streicher (Ashtabula, Ohio): Dr. Udelf says he took the temperature up to 140 degrees. Is there any reason why it should be at that temperature rather than at 130 or 120 degrees? The tissue response to temperature in some of the research work has been just a few degrees, regardless of the amount of the temperature given.

Also, in what type of ulcer is the Elliott treatment most effective? Is it the ulcer caused by systemic disturbances, or from infection from a foreign body?

Dr. Murray B. Ferderber (Pittsburgh, Pa.): I am not an ophthalmologist. I am interested in fever. The question I would like to ask is, What temperature the eye can tolerate; just how high can the temperature of that particular part of the body be raised? The temperature of the vagina and the uterus can be calibrated by using the thermocouple. I am wondering just how high the temperature of the eye can be raised before any changes other than beneficial may result.

Dr. Frederick L. Wahrer (Marshalltown, Iowa): Concerning Dr. Bryant's treatment, one thing that interested me was the question of applying the applicators in some acute cases of sinus disease in which the central deflection, which is quite common, was of such a marked nature that the nasal cavity on that side was more or less blocked.

I find in many of these cases the mechanical obstruction of the nose such that it is even difficult to place the very smallest type of applicators in the nose. We find especially in one-sided acute sinus conditions that the nose on that side often is almost completely obstructed.

There is no question concerning the advisability and the beneficial effect of heat. Most of our problems in recent years have been concerned with the best manner and the most efficient way of applying it.

Dr. R. L. Witherington (Cookville, Tenn.): I would like to have Dr. Bryant tell us what he thinks of the benefit of, or whether he has used the short wave treatment applied to the nasal bridge and over the sinus, and what he thinks of that treatment in comparison with the Elliott technic.

Dr. Frederick L. Wahrer (Marshalltown, Iowa): I was very pleased with the fact that Dr. Bryant brought out the inadvisability of using in these cases such vasoconstrictors as cocaine and adrenalin and, to a certain extent, ephedrine.

They are effective for a time, and one obtains an open nose, but in some instances there is a temporary cessation of the action of the mucous membrane cilia in any place for about half to one hour, with a resulting congestion as the effect of the drug wears off.

That, in turn, will demand more opening up, which brings about a vicious cycle.

Dr. Edwin B. Bannister (Monroe, Mich.): I would like to ask Dr. Bryant if he has had any experience with the use of the Elliott treatment in the eustachian tube for chronic sinusitis.

Dr. Frank L. Bryant: In the first series of patients whom I reported, we ran a few audiograms, and there was an improvement although they did not directly treat the eustachian tube. But those were merely audiograms taken before treating the patient with chronic and sub-acute sinusitis, and they were run again after the treatment was completed. In some there was an improvement in hearing, but the treatment was not directed to the eustachian tube. There was merely nasal and perinasal treatment, as I indicated. That, however, we are doing some further study on, and we will have reports on that a little later in the year.

Dr. Frederick L. Wahrer (Marshalltown, Iowa): I might answer, to a certain extent, the query concerning short wave. I have had no experience with the Elliott treatment, but I have had considerable experience with short wave radiation. I have found the treatment of acute sinus disease quite effective, both with the short wave and with infra-red heat. I have also found that from the patient's standpoint the short wave is preferable, not because of any great difference in clinical result, but because of the difference in time spent in the treatment. I believe that I can get the same result with infra-red that I can get with the short wave, but there is a difference of some thirty or forty minutes in the treatment.

I also do not rely entirely upon heat. I combine either short wave or infra-red heat with some modification of the Dowling pack, which I find is an improvement over the application of heat alone.

Infra-red heat, to be effective, must be mild and given over a period of forty to sixty minutes. Intense heat, given for a period of fifteen minutes, I find, is not effective. Short wave, however, can be given and completed very nicely in from ten to twenty minutes, depending upon the intensity of treatment.

Dr. R. L. Witherington (Cookville, Tenn.): How do you apply the electrodes with the short wave?

Dr. Frederick L. Wahrer: The electrodes can be applied to a single side. I generally apply one over the affected area and the other to the back of the head. If both sides are involved, I apply it bilaterally. It really does not make very much difference, because a parallel circular magnetic field is established there which gives the same result, whether one passes through and through, or places the electrodes side by side.

Dr. H. Grady Garrett (Dallas, Texas): What is the number of treatments given in those cases?

Dr. Frederick L. Wahrer: That depends upon the individual and upon the severity of the infection as to how long the patient has had it. If seen early, within twenty-four or forty-eight hours, the majority of the patients are materially relieved in perhaps forty-eight hours and the course of disease pretty well broken up in perhaps three or four days.

Dr. Frank L. Bryant (closing): Dr. Pretz stated in 1932 that one is convinced that ciliary function is the greatest physiologic factor in the prevention and resistance of infection wherever it exists, and is the first consideration that is to be thought of when treatment is instituted. Other functions of the nose are important and are directly related to this particular ciliary activity.

In regard to Dr. Wahrer's question about the deviated or deflected septum, we have had a few patients who have had septums similar to those seen by Dr. Wahrer. There are three sizes of Elliott nasal applicators. One is extremely small, and it so happens that in no patient have I had any difficulty—that is, I have had difficulty, but I have never been unable to insert the smallest applicator.

In those patients, of course, the treatments are necessarily longer— that is, not only is the duration of the treatment necessarily longer, but the whole time allotted to recovery is necessarily longer by virtue of the physical deformity.

In answer to Dr. Witherington, I have had no experience with the short wave. I believe there are other men here who undoubtedly are able to answer his question or tell him more than I can about that, so that I would rather not talk about something about which I know nothing. It would however be interesting to compare the two methods.

Dr. M. S. Udelf (closing): I will start by answering the last question. All I know is that the highest temperature I have been able to use is approximately 145 degrees. Whether the patient can tolerate more on the eye or less, I do not know. I will say that the toleration is dependent upon the method used.

With the Elliott treatment we can tolerate more because we are able to gradually increase the head and build up a tolerance to it, while with hot compresses their application is almost like an onslaught unless one can start with a cooler compress and then increase the heat.

Dr. Murray B. Ferderber: Do you have any idea at all of the temperature the eye can tolerate?

Dr. M. S. Udelf: No, I haven't. I have often thought of checking that, and there is no doubt that it is certainly not what the gage registers. Just what it is we have never checked.

In answer to the question about what type of ulcers treated, we use it on all types, because this particular therapy does not eradicate any other therapy; it is used as an adjunct.

In answer to the question regarding the comparison with electric pads, I have never used an electric pad. Perhaps Dr. Witzeman can tell us whether they have a gage to control the temperature when using an electric pad.

Dr. L. A. Witzeman: No, they do not.

Dr. M. S. Udelf: Then I would answer by saying that the principal disadvantage of the pad is that there is no means of knowing how much temperature one applies, and no control. The Elliott technic has the advantage of an additional vibratory effect which is important, as can be seen from the good results. One can feel the applicator while it is in use. The massaging effect felt by our fingers is very definite.

Dr. M. S. Udelf (additional closing remarks): One question I failed to answer was why use higher temperature when possibly 120 or even 110 F. would suffice in the face of this research work.

I do not think that a rise of temperature is desirable, except from the viewpoint of the depth of penetration we want, and there is no doubt in my mind that if we can attain 140 degrees, we are reaching the deeper tissues and therefore augmenting our therapy.

FEVER THERAPY AT HIGH HUMIDITIES *

WILLIAM FINKELSTEIN, M.D.

NEW YORK

The literature abounds in methods for the induction and maintenance of artificially induced fever, but it is not our present purpose to compare their relative merits. Undoubtedly in competent hands, the end results are uniformly good. However, the great majority of methods (with the exception of electro-pyrexia) still utilize cabinets in which moving air, at temperatures ranging between 125 and 150 F., with humidities varying from 30 to 80 per cent, is the medium employed. Under these conditions the hazards of fever therapy still exist and the patient experiences considerable discomfort. Stecher and Solomon[1] reported that out of 170 patients treated with high temperatures, ten had to be discontinued, three as a result of severe shock, and seven due to blisters or burns.

A number of years ago Schmidt[2] followed by Weiss[3] described a method of fever therapy utilizing the convection currents of warm water spraved over the body. After the desired temperature is reached, the patient is removed from the cabinet and the temperature maintained by hot water bags and blankets. In a series of over 4,000 treatments they reported no mortality or morbidity that could be in any way be attributed to the treatment. The temperature which they induced in their patients was moderate, ranging from 101 to 104 F. Quite recently Olsen[4] described the old fashioned steam room method of fever therapy. He pointed out its numerous advantages, stressing the comfort and safety of the patient, but failed to explain the mechanism temperature control. Behrend[5] attempted to explain the physiologic distribution of the blood during slowly increasing and strong stimulation. He found marked difference between the two, the former producing a dilatation of the peripheral blood vessels while the latter produced constriction. He stated that the best medium for producing a slowly increasing stimulation is water.

Personal experience has clearly demonstrated the value of higher humidities during therapeutic hyperprexia, as severe sweating is associated with marked reduction in plasma volume. The resulting dehydration induces certain changes in the acid base balance evidenced by an increase in the pH of the blood. The progressive alkalosis is directly related to the severity of the dehydration and degree of hyperventilation. Accordingly profuse perspiration causes a severe strain on the vascular and cardiac mechanism and may produce dehydration to even a fatal level of blood volume. All this can be obviated when fever is produced in dead air space at high humidities and lower temperatures.

Perhaps some of the greatest dangers of artificial fever could be avoided by a method whereby the blood volume could be adequately maintained and the acidbase volume remain undisturbed. At the Manhattan General Hospital in New York we have developed a very simple yet highly efficient method for the production and maintenance of artificial hyperprexia with the same type of cabinet used by Schmidt, but with a modification of technic, embodying all the advantages described by Olsen, maintaining the physiologic requirements of low cabinet temperatures with high humidities, yet affording precision in control.

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Technic and Effects

This method is of interest in that it utilizes humidities of 100 per cent throughout the entire treatment with a dry bulb cabinet temperature averaging 100 to 105 F. With this technic we are able to induce in patients a temperature of 107 F. in a period varying from an hour to an hour and one-half, and maintaining it over long periods with a maximum of safety and comfort.

The cabinet used is made of metal which is not insulated and has a moderate size air capacity permitting unrestricted movements of the patient at all times to any desired position. It is equipped with a sliding couch upon which the patient reclines on a comfortable sponge rubber mattress. A removable steel enclosure, providing ample space around the neck, is used to seal the front end and prevent irrational patients from escaping. Large sliding panels on either side of the cabinet permit easy access to or inspection of the entire body. Through the upper panel the arm can easily be slipped out for blood pressure determinations or emergency intravenous medication if indicated. An instrument panel at the front end, directly over the patient's head, is equipped with a thermostatic temperature control as well as levers for mixing hot and cold water to the desired temperature.

The induction of the pyrexia depends upon the vaporization of water taken from this mixing chamber and sprayed upon the body under mild pressure through nebulizers placed in the ceiling at the rear of the cabinet. The temperature of the spray is regulated by the thermostat and controlled by levers on the instrument panel. The warm spray at first feels very pleasant and soothing. The initial response is a marked vasodilatation of the peripheral capillary vessels, with flushing of the skin. In about fifteen minutes the temperature begins to rise slowly, the pulse is moderately accelerated, respiration is deepened but not increased, and there is a slight fall in blood pressure — the effects of slowly increasing stimulation. Quite often during the induction phase the patient may complain of discomfort or exhibit signs of restlessness. Some may appear anxious and worried while a few may develop tachycardia and demand to be released.

A feature of this method of fever induction is our ability to control these difficulties by the application of a cool spray turning on the cool faucet and pushing the control lever of the thermostat over to "cool." The effect of the cool spray is immediate and at times dramatic. Almost at once restlessness is allayed, discomfort is removed, and irritability lessened. The heightened color of the skin is momentarily blanched as a result of the contraction of the dilated peripheral vessels. It is important to note that this contraction of the vessels does not result in a lowering of the temperature but may even cause a slight elevation due to the charging of the splanchnic system with the overheated superficial blood, thus causing a more uniform distribution of the heat throughout the body. By far the most important effect of the cool spray is the change in the pulse rate. There is always a fall ranging from ten to twenty beats per minute, and this lowering of the pulse rate is maintained for some time. The cool spray invariably leaves the patient refreshed and willing to continue with the treatment. We may utilize this cool spray during the induction phase whenever necessary and permit it to continue for from one to three minutes at a time, depending upon the type of patient and the height of temperature desired.

The temperature is noted continuously at five minute intervals by means of a resistance thermometer using a rectal thermocouple. A temperature of 107 F. can be attained in about one to one and one-half hours without the least difficulty.

We maintain a temperature at any desired level for the required period by a process of "puddling," the explanation of which is as follows: Beneath the patient's bed in the cabinet is a metal compartment about three inches deep, constituting the bottom of the cabinet, and over which the sliding couch rests. This compartment contains the overflow outlet for the drainage of the water utilized in the production of the fever. The drain is fitted with a metal ring about one inch in height, so that there will accumulate a constant bed of water an inch high before it begins to overflow. Additional water may be let into this reservoir through a flexible tube attached to one of the nebulizers and leading directly to the bottom of the compartment. The water that flows through this nebulizer into the reservoir under separate control on the instrument panel. The temperature is likewise controlled by the thermostat.

After the induction phase is completed the spray is turned off completely and the "puddling" stream flowing directly into the bottom compartment is turned on at a temperature varying between 110 and 130 F. The heat that is thus generated is carried by convection to a higher level and rises in the compartment over the patient, thus maintaining a continuous cabinet temperature of 100 to 105 F. at complete saturation, equaling 100 per cent humidity. In this manner the temperature level can easily be maintained for a long time with a minimum of hazard and discomfort. The cabinet is never overheated since it is non-insulated and made of metal which, being a good conductor, permits the ready escape of any excess heat. The patient is permitted complete freedom of movement. Cold compresses are often applied to the face and head, and fluids are given as desired by the patient and rarely forced, usually averaging from 200 to 300 cc. per hour. We do not find it necessary to administer saline solutions since we find, as Warren[6] so ably developed, that a preliminary dose of 10 grams of sodium chloride in a 24-hour period preceding fever therapy is generally sufficient. The only sedative used is one and one-half grains of nembutal, given about one hour before beginning the treatment. Occasionally in refractory cases 1/6 grain of pantopon is given hypodermically and is sometimes repeated. Very often we found that no sedative whatever was necessary.

As in the induction period, the temperature level during the maintenance stage is followed continuously by means of the rectal thermocouple. Again at frequent intervals when necessary we can utilize the cold spray to great advantage, especially in controlling rapid pulse, tachycardia, extreme restlessness, fatigue and irritability.

There is very little necessity for forcing fluids since there is very little sweating, and consequently little loss of blood plasma volume. There is no hyperventilation and consequently little or no tendency toward alkalosis or anoxemia, and hence never any severe degree of shock. It is obvious that by utilizing such low cabinet temperatures, even the most minor superficial burns are impossible. For this reason there is no necessity for using additional insulation such as towels or bandages over the patient's chest or lower extremities, which would only add to his discomfort. It was interesting to observe that the majority of patients suffered no less of weight after the treatment in fact, many showed a gain, and since fluids are not forced the natural inference is that sweating is minimized and there is no dehydration whatsoever.

Clinical Observations

In addition to a few cases of mild tetany that were very easily controlled, there were only two serious complications. One patient who de-

veloped a marked degree of jaundice, and was desperately ill for about a week, and was seen by Dr. William Bierman, eventually made a complete recovery. In this case the temperature extended to 107.5 F. for about ten minutes, an error resulting from the use of the clinical thermometer instead of the continuous rectal recording thermometer.

The second case was that of an ex-college football player who was treated for acute gonorrheal urethritis, became irrational, and we thought it best to discontinue treatment. When he was removed from the cabinet, he became obsessed with the idea that he was being ambushed, and he physically assaulted the nurse-technician as well as myself, eventually requiring about a half-dozen able-bodied men to subdue him. This patient had started treatment with great trepidation, having been warned previously of its horrors by a urologist who had unsuccessfully treated him for the past nine months. How much this preliminary fearful state of mind contributed to his final outburst is problematic. It served as a lesson to provide necessary restraints within the cabinet for a similar emergency.

In addition to the usual cases of gonorrhea and its complications, all forms of syphilis, non-specific arthritis and chorea treated and cured, there was a case of non-specific ulcerative colitis, referred by Dr. Jacob Paepke. This patient's weight had fallen from 120 to about 76 pounds, and she was passing from twenty to thirty liquid stools a day containing a great deal of pus, blood and mucus. She had been suffering continuously for about a year and was steadily getting worse. She had been seen in consultation by a number of eminent physicians. This patient obtained a complete clinical remission of symptoms after six five-hour sessions of fever therapy at an average temperature of 105 F. twice a week. No other treatment was given and freedom from symptoms has now lasted for over six months.

Another interesting case was one of pelvic peritonitis following an attempted dilation and curettage, presenting a large, doughy mass in the right cul-de-sac. The patient was admitted to the hospital in a very serious condition. The gynecologist thought it best not to interfere surgically for fear of spreading the peritoneal infection, and after consultation it was decided to attempt fever therapy. Five treatments were given at two-day intervals with an average temperature of 104 to 105 F. maintained for three to five hours. The patient immediately began to show signs of improvement. The acute abdominal pain diminished and the size of the mass decreased. She eventually made a complete recovery and was discharged from the hospital as cured.

I wish to mention briefly here a phase of fever therapy of great interest. I refer to the combination of prontylin and fever therapy in the treatment of gonorrhea in the male and female. We are all quite familiar with the pronounced therapeutic value of prontylin.

Recently Dees and Colston[7] reported a series of 47 cases of various types of gonococcic infection of the genito-urinary tract, with a large percentage of cures. These findings have been in a great measure confirmed by other investigators, but the percentage of cures varies considerably. A review of the literature, however, discloses a number of serious complications from this form of therapy. Colbrook and associates[8] report several cases of sulfhemoglobinemia, while others noted methemoglobinemia with nausea, cyanosis, fever rash and extreme dizziness in many instances.

Harvey and Janeway[9] reported the development of several cases of acute hemolytic anemia during the administration of sulfanilamide and attributed the effect directly to large doses of the drug. These ill effects could in the main be attributed to excess dosage.

We are also well aware of the serious complications and great hazards of the high and prolonged fever required in the treatment of gonococcic infections.

Recognizing that prontylin as well as fever is a specific method for treating these infections, and being mindful of the dangers of either method, it seemed that the treatment might be fully as effective and the hazards of each method minimized by administration of a lesser amount of prontylin over a short period, and the application of a shorter session of fever at lower temperatures. It also seemed possible that this combined method might be a means of curing cases that failed to respond to either form of therapy alone.

We were able to treat by this combined method about fourteen cases. Included in this group are four patients who had failed to respond to routine prontylin therapy and one who had previously received fever therapy without beneficial results. At first we used different combinations, but in the last six cases the procedure was to give the patients a preliminary dose of 10 grams of prontylin in the 48-hour period preceding fever, and to follow this immediately with six to eight hours of sustained fever at an average temperature of 106.4 F. Five of these last patients were cured by this method, as evidenced by the cessation of clinical symptoms and negative laboratory findings. Of the remaining eight treated in this manner, six were cured.

While recognizing that the number of cases treated is hardly sufficient to warrant any decisive conclusions, and that the time since the termination of treatment is too short, I present this preliminary report in an effort to direct attention to the possibilities of this field of research so that eventually some combination of the two methods could be elaborated that should prove specific for all cases of gonorrhea.

Conclusions

Fever therapy at high humidities and low cabinet temperatures, with water and air as the medium employed for the production, maintenance and decline of temperature, minimizes the hazards and provides a maximum of safety and comfort.

The cool spray can be used at all stages to control rapid pulse, extreme restlessness, anxiety and cardiac palpitations. It may also be utilized to prevent a too rapid rise in temperature as well as to facilitate the fall at the termination of treatment.

Prontylin combined with fever therapy seems to offer an effective way in which to treat all cases of gonococcic infections, reducing the hazards of either method alone. The exact combination must still be determined by further experimentation.

256 W. 79th St.

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(*Continued on page 762*)

REHABILITATION OF THE PHYSICALLY HANDICAPPED *

HENRY H. KESSLER, M.D.

NEWARK, N. J.

The goal of rehabilitation is the improvement of the mental and physical powers of the disabled person in order to meet the competition of those who are free from physical defects. By means of vocational training and physical restoration these powers can be improved, so as to enable the handicapped person to earn a livelihood.

The large group of the disabled who seek the services of rehabilitation agencies frequently have disabilities which may be corrected wholly, or in part, by medical or surgical measures. Every effort should be made to discover whether the maximum physical restoration has been obtained, even though the disability be of long standing. This may be accomplished in three ways: by surgery, by prosthesis and by functional re-education.

Restorative Measures

Through the use of well recognized orthopedic operations, physical disability may be reduced and function enhanced. Ununited fractures are stabilized by bone grafting, flail joints are immobilized by arthrodesis, and paralytic deformities are improved by fixation operations on the joints, or by tendon transplantations. In considering any surgical plan the objective must always be the ultimate job restoration of the individual. The operation may, therefore, be designed for specific ends or only for local improvement.

Among those who require prosthesis the amputation case is one that requires careful consideration. Improvement is facilitated by providing these individuals with artificial appliances. The prosthesis serves to remove the psychologic aversion to the cripple by replacing his missing member, and offsets the economic prejudice of the employer by the increase in industrial efficiency of the amputee.

The physical restoration of the crippled and disabled is achieved in the larger proportion of cases by means of functional re-education. In many instances it may be necessary to complete the entire plan of physical rehabilitation before educational training or employment becomes feasible. A tailor, for example, who sustains an infection that leaves a disabling stiffness in the hand and fingers, must often reconstruct his social and industrial life. Two courses may be open to him depending upon the extent and severity of the disability. After his discharge by the physician, he may seek employment at a very much reduced capacity, necessitating a readjustment to a lower standard of living. On the other hand he may find it more advisable to obtain further medical aid, with the view to improving the physical condition of his hand by a course of intensive after-treatment, followed by the development of the remaining physiologic functions of the hand, and thereby find it possible to return to his former vocation and employment. This should always be the primary goal of the rehabilitation service. Change of vocation is a severe strain on the morale of the disabled person, especially if a reduced earning capacity is entailed. It is more rational to utilize medical and physical methods to overcome the physical disability and thereby prepare the disabled individual to return to his former work.

* Read at the Eastern Sectional Meeting of the American Congress of Physical Therapy and the New York Physical Therapy Society, Newark, New Jersey, May 2, 1937.

Importance of After-Treatment

The recognition of the importance of after-treatment in all cases of injury received a strong stimulus from the reconstruction hospitals, during and after the World War. This treatment is based essentially upon principles established long ago by John Hunter. He noted that the restoration of function was dependent upon the natural properties of living tissues to heal. He, nevertheless, stressed the importance of the surgeon's responsibility in the encouragement of the patient's will to recover function. Without the patient's co-operation the work of the surgeon is futile.

There is no better means of achieving this latter objective than through occupational therapy. In addition to massage, splinting and mechanical treatment, maximum functional restoration of an injured part can be obtined through systematic and active use. Apart from the improvement of physical disabilities, psychologic attitudes and morale are also aided by these procedures. Occupational therapy received its greatest impetus immediately after the World War, and has been applied with success to the disabled in industry and civil life. Curative workshops have been established throughout the United States, a few associated with hospitals. The effect of work treatment in the rehabilitation of disabled persons may be noted in the following cases:

Case 1. — G. F., aged twenty-nine, was admitted to the curative workshop with little hope of readjustment, since his past failures in industry made any effort at rehabilitating him, seem futile. Even to himself the idea of training was a waste of time and a practical joke. The spastic hemiplegia he had suffered as the result of a birth injury was sufficient to render him a permanent and hopeless invalid. Though his attendance was forced at the beginning, he later manifested such physical and mental changes through occupational therapeutic practices, that we were able to secure employment for him a year after admission to the shop. Continual practice, training and application in the use of his remaining good arm qualified him for the position of an automobile painter. He has remained gainfully employed for the past six years with the same organization.

Case 2. — G. H., at the age of forty-two, suffered a fracture of the spine with a partial spastic paralysis of both lower extremities as the result of an industrial accident. He was admitted to the workshop on crutches and applied himself immediately to the occupational therapeutic procedures. He began his work treatment by the use of the hammer, saw and file. Since he demonstrated a remarkable work capacity despite his disability, his productivity increased in spite of the demands made upon him. The crutches were discarded and replaced by a cane. After six months in the shop the cane, too, was discarded and he undertook a contract to build a 42-foot boat.

Case 3. — W. F., age, 22, suffered hypersensitivity of the right hand due to a median nerve causalgia. Alcoholic injections gave partial relief. He was admitted to the Curative Workshop and was provided with a heavy canvas glove. With the use of his hand the sensitivity was reduced. Thinner gloves were substituted and heavier work assigned until he was able to perform ordinary work without the aid of gloves.

After discharge from the shop the young man reported that he had been working in a C. C. C. Camp without much difficulty.

Case 4. — R. P., age 54, sustained an injury to his right ankle, left shoulder, spine and head as the result of a fall from a derrick car. He felt convinced that he never again would be able to work. Medical examination disclosed a rating of 50 per cent permanent disability.

This man complained continuously of severe pain and refused to listen to any plans for his rehabilitation. After several years of obstinancy he was finally persuaded to enter the curative workshop. Observation proved that his complaints were exaggerated in the hope that compensation might be continued indefinitely. His opposition relaxed and interest stimulated in the shop. Here he proved his ability for consistent work in a seated position on any project for personal use. After a project was completed he, invariably, remained at home, "very sick" until his landlady requested a collapsible ironing board, a sewing cabinet and similar articles. These he would complete without any painful interruption. In the course of 9 months a list of 24 projects were accumulated as evidence of his productive versatility in laborious tasks.

Conclusion

The crippled and disabled are capable of wide and prolonged usefulness. By rehabilitating them in occupations and industries for which they are suited, society may be relieved of the burden of providing asylum and relief for this group.

Through special vocational training the handicapped person may become qualified to find his place with the normal worker.

The greatest hope, however, lies in physical restoration, although a certain proportion will require special surgical or prosthetic services. The larger number will achieve their adjustment through functional education and practical encouragement.

Discussion

Dr. L. Szerlip (Newark): The rehabilitation of the physically handicapped has reached a high degree of development as shown in Dr. Kessler's paper. The disabled man is now given careful study and his treatment follows a definite pattern. Good surgery performed on a crippled limb can be completely lost if it is not carefully followed and adequately treated by physical therapy, administered by skilled hands. Functional re-education and occupational therapy may be considered a part of a broad scheme of physical therapy.

Careful surgery and conscientious aftercare fall far short of the desired end if the various mental and psychic aspects of each case are not carefully borne in mind throughout the treatment. Dr. Toye has made reference to this aspect of the problem and has presented some very pointed comments.

The objective in the development of all branches of medicine has always been prevention. Those of us who are interested in rehabilitation approach the initial injury with a new definition of the "end-result." That result can no longer be regarded as satisfactory which consists only in anatomic restoration and a clean wound. The accomplishment of these most desirable results may fall short in the presence of a joint ankylosed in a useless position. Persistent edema (with its aftermath of tissue fibrosis) and contracture deformities are but a few other examples of avoidable disabilities. To the end that rehabilitation may reach even greater heights of achievement, these obstacles to real "end-results" must be overcome.

They can only be overcome when the physician visualizes the whole problem of rehabilitation before him when he first sees an injury. The true "end-result" must be in the mind's eye with every suture, in every manipulation and in his daily management.

The diet we serve the physically handicapped to strengthen and heal them must contain the vital courses we call physical restoration, functional re-education, vocational guidance and placement. Prepared with fewer avoidable deformities and seasoned with sympathy, understanding and encouragement, this food cannot fail to nourish the physically handicapped back to self-support, independence and social standing.

Dr. John E. Toye (Arlington, N. J.): From training and experience Dr. Kessler speaks as one having authority. It has been his work for "lo! these many years" to examine — operate and train the industrial cripple, all to bring him into a condition of self-support and self-respect. For it is axiomatic that the man who is normal or even approximately so, cannot be self-respecting if dependent.

To be sure there are among our very diverse population many who do not enjoy work of any description, but these are not even remotely normal by our present day standards. What their standing may be a few years hence, with the present governmental tendencies is another story or guess.

Which brings us to one of the problems of rehabilitation on which Dr. Kessler has but touched in his paper — namely, the psychology of the industrial cripple.

He is usually a man who has been very strong, rugged, healthy. He has given no consideration to illness or crippling because, in common with most of us, he has not considered that anything could happen to him. When suddenly he becomes unable to carry on in his usual manner, something happens to his morale. He is not prepared for it and his whole moral structure is shaken. He is psychically lost. He becomes depressed, morose, pessimistic, and thoroughly out of tune with his surroundings.

This man is a truly pitiable object and the most difficult task of the whole rehabilitation process is to gain his confidence that he may again be of some value in his world. When he has once been convinced that he may regain some part, great or small, of his former productivity and facility of performance the process of rehabilitation has gone a long way.

The rehabilitation surgeon must be a good psychiatrist. The operative procedure is, as a rule, the simplest and easiest part of his work. Selling the idea and keeping up the morale of these men during the postoperative period of physical therapy is quite as important and equally difficult.

It is not easy to arouse enthusiasm in a man of forty or thereabouts when he is told that he must learn a new occupation after spending his life in some particular trade, skilled or otherwise. It is a difficult thing for him to do and calls for considerable stamina and flexibility. And on the part of the surgeon there is need of a fine sympathy and understanding as well as a thorough

psychiatric skill — natural or acquired. Results will depend very largely upon this as well as upon the individual patient.

Dr. M. Weinstock Bergman (Newark, N. J.): May I add a few remarks concerning the neuropsychiatric aspects of our rehabilitation patients. Having had the pleasure of consulting with Dr. Kessler in about 100 cases, the realization of preliminary study is imperative. For example, when an individual loses a limb and passes through a period of "mourning and melancholia" because of the loss of a loved object, he develops many psychoneurotic manifestations which revert back to himself and last until the affection can be transferred to a new interest. Overcoming the resistance by competent guidance and establishing a transference to the physician by a sort of companionship, skillful guidance is assured, incidentally establishing the importance of the attending physicians possessing the proper personality for this therapy. My efforts toward proper selection have been directed to eliciting the strivings, urges and interests compatible with the selected therapy. If the patient is oralistically inclined, positions requiring speaking must be sought. If sadistic tendencies are discovered, then outlets in hammering and construction are advised. If the patient shows masochistic or esthetic tendencies, then attempts to create desires in art, florist work or decorative lines are suggested. If the patient is narcistic or exhibitionistic, desires good clothes, an occupation deriving greater income is required. If he displays a fetich for wood, paint, glass or metal, particular training in the selected art is followed. A necessary prerequisite is, of course, a corresponding physical status. If the urge or desire is incompatible with the physique, such as a markedly disabled youth requesting an aviation career, or a deficient mind to follow a scholastic career for electrical engineering, it becomes the neuropsychiatrist's duty in conjunction with the rehabilitation staff to skillfully persuade the patient by suggesting other lines.

The Curative Workshop and Rehabilitation Clinic becomes a laboratory for the physician. To derive greater results the physical therapy department can treat neuritic manifestations, atrophied muscles and other deficiencies. The interrelated biologic and psychologic development can, therefore, be followed as Dr. Kessler has described.

TREATMENT OF COLON INFESTATION BY IRRIGATION AND HOT INSTILLATIONS *

DAMASO DE RIVAS, Ph.D., M.D.

PHILADELPHIA

The life requirements of parasites of man do not essentially differ from other forms of life except that in their parasitic evolution they have come to require a host in order to survive. Furthermore this parasitic adaptation has developed to such a degree that the parasite in order to survive it must also enter and lodge in an organ of the host. Thus amebas are parasites of the gastrointestinal tract, plasmodia invade the red blood cells, hookworm, the duodenum, clonorchis, the liver, paragonimus, the lung, and the adult tapeworm the small intestine. These organotrophic peculiarities, as may be readily understood, are not necessarily selective on the part of the parasite, which may lodge indiscriminately in any tissue or organ of the host, but merely incidental, which eventually reaches the place where appropriate food, moisture and warmth are favorable for its growth and reproduction.

Of these three most important requirements for the maintenance of life: food, moisture and warmth, the latter is so important that a variation in the environmental temperature when too low and more specially when too high, produces profound deterioration and eventually rapid death. And this applies especially to parasites which through their evolution have become adapted to the constant normal temperature of the host. The unfavorable effect of high temperature on parasites of man explains the spontaneous expulsion of tapeworm, ascaris and other intestinal parasites, not uncommonly

* From the Department of Parasitology, Tropical Medicine and Pathology, University of Pennsylvania.

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seen, during the febrile stage of smallpox, typhoid fever, pneumonia and other acute infections accompanied by high fever.

A rather interesting observation in this connection is also the method used by natives of Africa and tropical America for the removal of ticks attached to the skin, which consists in the application of a hot pebble or Indian corn, a lighted cigar or cigarette near the back of the tick. This procedure is invariably followed by the insect withdrawing its jaws from the point of attachment and subsequently dropping from the skin.

Thermal Death Point of Intestinal Parasites

Based on the above observation the writer conducted a series of experiments on the effect of temperature on the life of protozoan and metazoan parasites with the result that a relatively small variation of 45 to 47 C., was sufficient to kill these parasites in 5 to 10 minutes in the accompanying table.

TABLE 1. — *Effect of Temperature on the Vegetative Form of Endameba Histolytica from Feces of an Acute Case of Amebic Dysentery.*

Temperature	Time of Exposure	Results
5 to 10 C. in ice chest	24 hours	Many alive
	48 hours	Few alive
	72 hours	All dead
22 to 23 C. in room temperature	24 hours	Very few alive
	48 hours	All dead
37 to 38 C. Incubator Temperature	12 hours	Very few alive
	24 hours	All dead
40 C. Incubator Temperature	1 hour	Very active
	5 hours	Few alive
	12 hours	All dead
43 C. Incubator Temperature	10 minutes	Very active
	1 hour	Few alive
	2 hours	All dead
45 C. Incubator Temperature	1 minute	Very active
	5 minutes	Few alive
	10 minutes	All dead
47 C. Incubator Temperature	3 minutes	Few alive
	5 minutes	All dead
50 C. Incubator Temperature	2 minutes	Very few alive
	3 minutes	All dead
52 C. Incubator Temperature	1 minute	Very few alive
	3 minutes	All dead
55 C. Incubator Temperature	30 seconds	Few alive
	2 minutes	All dead
60 C. Incubator Temperature	30 seconds	Very few alive
	1 minute	All dead

From ancient time to the present, perhaps due to a lack of better understanding of the nature of parasitic infestments, unfortunately the treatment of these affections has been entirely empiric, based on the administration of certain drugs or preparations such as emetin, santonin, chenopodium, thymol, tetrachlorid, oil of male fern, jetran, stovarsol, carbason and a score of other synthetic preparations of high arsenic and iodin compounds, advertised as "specific." As these drugs are toxic substances, to be effective on the parasite they must be administered in doses often more harmful than beneficial to the patient.

The method to be described is based on the killing of the parasite by the application of heat, without causing any detrimental action on the patient.

This is recommended for the treatment of amebic dysentery, infestment with trichomonas, chilomastix, and oxyuris (pinworm) and other parasites of the large intestine.

The method consists in the application to the colon of a 1 to 5000 hot copper sulphate solution through a rectal tube. A graduated glass receptacle or tank, of 2-liter capacity is filled with the hot copper sulphate solution at a temperature of from 50 to 53 C., and is suspended about 4 feet above the lavage table. A rectal tube, about one-half inch in diameter, is attached to the container. The solution is first allowed to flow to remove the air, and after applying vaselin to the anus the tip of the tube is gently introduced, two or three inches into the rectum. A rectal thermometer is also introduced about four inches past the anus to control the temperature.

The intubation of the colon is a comparatively simple manipulation provided the rectal tube be moderately flexible and of proper caliber, and the patient lies on the right side with the hips slightly elevated. Still more important, however, is to avoid bending the tube by using gentle force and being sure that a flow of liquid, which spreads the walls of the intestine, precedes the advancement of the tube into the colon. During the operation the temperature as registered by the rectal thermometer should be carefully watched and not permitted to exceed 45 to 47 C., which may be easily controlled by regulating the rate of flow of the liquid from the tank and by siphoning it off if necessary.

The quantity of liquid to be injected depends upon the condition to be treated and the reaction of the patient. As a rule, 500 cc. of hot copper sulphate solution can be injected and as much as 1 to 2 liters may be introduced into the colon without appreciable discomfort to the patient. Should, however, the patient at any time feel any undue discomfort, the liquid should be siphoned out through the discharge rectal tube by closing the tube from the tank and opening the discharge tube leading to the bucket. The efficacy of the method does not depend so much upon the amount of liquid introduced as upon the maintenance of the temperature of 45 to 47 C., in the colon from five to fifteen minutes, which experience shows to be sufficient to kill amebas and other protozoan and metazoan parasites of the large intestine (table 1). In order to avoid undue distention of the colon and unnecessary discomfort to the patient, a safe procedure is to inject the solution slowly and to siphon off the excess of liquid at the request of the patient.

Amebic Dysentery

Several drugs and preparations have been regarded as specific in the treatment of amebic dysentery, such as ipecacuanha, emetin, jatren, stovarsol, emetin-bismuth-iodine and carbason, of which emetin is more generally used. Rogers is of the opinion that emetin is the preparation of choice, but according to Low, of the London School of Tropical Medicine, only one-third of the cases are cured by this drug, one-third are improved and one-third are practically unimproved. This has been corroborated in my experience.

In this connection the fact should not be overlooked that most parasitic diseases are characterized by a slow course in the form of irregular acute attacks alternating with periods of remission. This is especially true of amebic dysentery in which the patient may have an acute attack of frequent defecation, tenesmus, mucous and bloody stools and general gastrointestinal derangement lasting a few days to one to two weeks. In time this acute attack commonly subsides, only to reappear several weeks or months later. With this in mind it can be appreciated that the amelioration or symptoms

following the use of any medication may not necessarily indicate a specific action of the drug, but a coincidence with the period of quiescence.

If such amebacidal action of any of the drugs recommended were specific, the treatment of intestinal amebiasis would be greatly simplified, as it would only involve a routine course of injections or oral administration of a given preparation. Unfortunately, however, clinical experience shows that such is not the case. Furthermore, this attitude is apt to encourage a false optimism and a tendency to neglect other factors of greater importance in the successful treatment of amebic dysentery. In a case with an unusually heavy infection of more than three years' duration, in which the patient had received more than 100 injections of emetin, as many as 30 or more amebas could be counted in a fresh cover-glass preparation of the mucous discharge from the bowel under the high power of the microscope. Under a less dogmatic treatment he made a slowly progressive recovery, was well in six months and has remained free from dysenteric symptoms and from amebas in the feces after fifteen years observation. In my experience the treatment which has given the most satisfactory results may be briefly described as follows:

1. During the acute attack, after the diagnosis is established and the nature of the lesion determined, if the symptoms include tenesmus, painful and frequent defecation, the bowels are put to rest with large doses of bismuth, 10 grains, three or four times a day, and paregoric, 1 drachm, every four hours, until the acute symptoms subside.

2. Treatment by the intra-colonic thermal method as above described, two or three times a week for the first week, twice a week for the next two or four weeks, and once a week for the following two or three months or longer if necessary.

3. A course of subcutaneous injections of one-half grain of emetin hydrochlorate every day or every other day, according to the tolerance of the patient to the drug. This may be repeated for several doses if necessary.

4. The anemia commonly present should be treated by oral, subcutaneous or intravenous injections of iron and arsenic. As a routine procedure, I employ intravenous administration of iron and arsenic, cacodylate of sodium, as experience shows that a more rapid result is obtained with no ill-effect or inconvenience to the patient.

5. Organic or metabolic disturbances should receive proper attention.

6. The patient should be advised to eat plenty of nutritious and easily digestible food. Roughage should be avoided during the acute symptoms because of its irritating effect on the intestinal track. A restricted diet in most cases is contraindicated as the disturbances of metabolic equilibrium may lead to emaciation and diminution of the natural resistance.

7. The assumption of a cure in the treatment of amebic dysentery should be based on the absence of involvement of the appendix, liver and other viscera, and the disappearance of the parasite (E. histolytica) from the feces after months or even one or two years of observation, rather than on the rapid and commonly premature disappearance of the acute symptoms.

The administration of yatren, stovarsol, carbason and a score of other synthetic preparations, is contraindicated.

In this connection the reader is referred to an editorial* in which among other things it is stated:

> It is quite a common experience and rather a startling one to experts in human parasitology to hear these clinical neophytes, or those whose knowledge has been gained merely by reading literature, speak glibly on such-and-such a drug as being "specific" as an amebiacide. To them, the treatment of the infection means the simple exhibition of emetin and one of the arsenic or iodine-rich drugs. Unfortunate

* Edit.: Medical Therapy to Combat Amebiasis, Am. J. Dig. Dis. & Nutrit. **1**:147 (April) 1934.

though it be, medicinal therapy for amebiasis cannot be learned from reading advertising pamphlets or the slips in trade packages of drugs. Undoubtedly, much of the confusion extant comes from those made familiar with clinical amebiasis only during the past half year, attempting to use 'specific' therapy as exampled by the 'newer' drugs, endeavoring *to fit the patient to what the advertising circular* advises, and failing to have a proper appreciation of how *Endameba histolytica* produces its peculiar pathology, its clinical symptomatology and its constitutional effects . . .

To those clinicians or "armchair therapeutists" to whom human amebiasis has swung acutely into their professional ken and who speak so confidently of the need for the employment of the 'new' specific remedies, it should be told that before the market was filled with jatren, treparsol, carbasone, stovarsol, chinofon, vioform, *et al.* amebiasis, acute or latent, was treated probably quite as successfully as it is now by drugs which are named in the standard pharmacopoeias and which, not only are cheap and accessible, but are relatively harmless. . . . It behoves the average practitioner to question the advisability or the necessity for the exhibition of the 'New' arsenic or iodine-heavy compounds, mixtures or combinations so admittedly dangerous that no trade package is marketed without its accompanying circular of warning. There is much need for such warnings; one has but to see patients to whose amebiasis has been added medicinally-induced, extensive exfoliative dermatitis, optic atrophy, degenerative spinal cord or peripheral nerve damage or parenchymatous destruction of the liver or kidney . . . .

Recently there has been a tendency to omit colon instillations from the therapeutic armamentarium of acute amebiasis. deRivas has proved that the thermal deathpoint of endameba histolytica is but a few degrees above 100 F. When properly administered in suitable instances, undoubtedly the daily or twice daily instillations of several liters of normal saline solution at a temperature of 110 degrees F., acts favorably against the trophozoites, perhaps cysts, cleanses the lower bowel, limits the quantity and kind of the so frequently associated dysentery-producing bacteria, and to a patient greatly shocked and dehydrated by frequent bowel movements, contributes fluid in such quantity as may enable him to weather the crisis. One has only to observe the effects of slowly-given colon-irrigations, via the two-way tube of small calibre, to be convinced of the favorable influence of taking advantage of deRivas' studies."

Special Infestations

Trichomoniasis. — The oral administration of drugs for the treatment of triochomoniasis may produce only incomplete removal and seldom eradication of the parasite. This may be readily understood because any antiseptic, astringent or poisonous effect which the drug may have on the parasite is nullified by its previous absorption or modification during passage through the small intestine, before reaching the colon. The direct application of parasiticidal substances or of a physical agent detrimental to the life of the parasite is therefore a logical procedure. The treatment which has given me the most satisfactory result, is as simple as it is efficient. It consists in washing the colon with hot copper sulphate solution at the rectal temperature of 45 to 47 C., as above described. A single treatment rarely produces the desired result; as a rule, 5 to 10 or more treatments, every other day, are necessary for the eradication of the parasite.

Oxyuriasis. — Attempts to eradicate the parasite by oral administration of anthelmintics is of no value and even contraindicated. The administration of enemata of quassia, 1 ounce in a pint of water, or tannin, ½ drachm in a pint of water, is unsatisfactory as it merely gives temporary relief. The best result is obtained by washing the entire colon with hot solution of 1 to 500 copper sulphate at rectal temperature of 45 to 47 C. for ten to fifteen minutes, two or three times a week, repeated if necessary as above described until repeated examinations reveal no adult parasites or eggs in the feces. Washing the hands and anal region after defecation and refraining from scratching and biting of the nails is of importance for the prevention of reinfection in the successful management of each case.

It may not be amiss to mention that though oxyuriasis is generally con-

sidered a mild and to some extent unimportant parasitic infestment because it rarely gives rise to acute clinical symptoms, nevertheless it is often apt to produce serious psychic and nervous phenomena as well as mental abnormalities. One of the constant symptoms is pruritus appearing with remarkable periodicity at bed time. This is not due of course to any peculiar activity of the parasite at these times, but to relaxation of the patient at this hour during which external stimuli are apt to make a stronger impression. This is especially true in young girls in which the parasite may cause irritation of the external genitalia leading to vaginismus, nymphomania, sexual perversion and erotic dreams. Furthermore oxyuriasis has been found to produce important organic disturbances by its invasion of the uterus and other internal sexual organs.

Trichocephaliasis. — Trichocephaliasis is a relatively mild infestment of the large intestine, and cecum and occasionally the appendix. It is caused by the commonly known whipworm, *Trichuris trichura* (*Trichocephalus dispar*). The administration of anthelmintics by mouth frequently has no effect. Higueron, the fresh milk of the plant — *Ficus laurifolia*, administered by mouth is claimed to give more satisfactory results. Lavage of the colon with hot 1 to 5000 copper sulphate solution, as above described, will be found to give the best results.

Conclusions

1. Based on experimental studies in vivo and clinical observations the writer believes to have found a more efficient and safe procedure for the eradication of parasites of the large intestine by the application of hot instillations to the colon of 1 to 5000 copper sulphate solution.

2. Since symptoms of parasitic affections of the colon may in many ways be mistaken for appendicitis and other pathologic conditions of the lower abdomen, as a precaution, especially as to the post-operative prognosis, the presence of intestinal parasites should be determined by the examination of the feces before advising an operative procedure. This would avoid embarrassment to the surgeon and disappointment to the patient.

3. The oral administration of anthelmintics and other so-called "worm medicine" and a score of modern synthetic preparations advertised as "specifics" against parasites of the intestine give only temporary relief and are often more harmful than beneficial.

Discussion

Dr. J. S. Hibben (Pasadena): In Southern California the incidence of intestinal parasites is alarmingly on the increase due to the fact that our fresh vegetables are supplied by orientals who are notoriously known to harbor intestinal flukes and parasites, as well as our closeness to Mexican border towns which are frequently visited. Nearly all Mexicans are infected, yet they prepare and serve the food in the best Mexican hotels. I almost routinely make a stool examination, amebic dysentery and bacillary types being those most commonly found.

I have not yet had the courage to abandon entirely the oral use of such drugs as Stovarsol, vioform, chinofon, carbason, which are arsenic, bismuth and iodine compounds, etc., but I use less of them and follow Dr. de Rivas' method of treating the entire colon with hot saline solutions. I have abandoned the use of medicated solutions. My opinion in common with others is that they are of doubtful value. As the essayist has pointed out, the application of his method is a delicate operation and should preferably be given by a physician thoroughly familiar with the technic.

It is for this reason that I use the Dierker Therapeutic Apparatus. This is a safe and easily controlled instrument which employs pressure and vacuum. A mercury manometer which indicates the degree of pressure and vacuum mechanically induced, as well as pressure changes that may occur within the bowel during treatment, gives visible and diagnostic values which I have never had with any other equipment. The bowel is cleansed, at the same time keeping the motility as nearly physiologic as possible. It must be remembered that in these cases we are not treating a normal bowel and the me-

chanical aspects of passing tubes into a traumatized bowel with diverticulosis, ulceration, and the like, is not without risk. It is gratifying to know that Dr. de Rivas is not an exponent of that relic of antiquity, the long tube whose most ardent supporters admit it can be passed into the cecum in but 20 per cent of normal cases.

I would like to ask Dr. de Rivas if he has used short wave or conventional diathermy to the abdomen in amebic cases before irrigation and treatment of the colon. He states that the thermal death point of entameba histolytica is a few degrees above 100 F.

Dr. Anna Hagemann (Cincinnati): Whether we are dealing with bacterial infection or parasitic invasion of the intestines, the natural course to follow is to run out the invaders "bag and baggage" as speedily as possible. This is the task of colonic irrigations, to rid the intestinal tract, especially the colon, of the material on which these organisms subsist as well as the organisms themselves, preparing the way for other therapeutic measures to be administered in whatever way they may be needed orally, hypodermically, rectally, as well as giving the bowels a chance to act normally and use the natural body defenses.

In the question of colonic irrigations the responsibility of the practitioner is of first importance, and should be insisted upon. There is no place in this work for the commercial operator, even though in the hands of the tyro, colonic irrigations often brings results. The beneficial results of even partially cleansing the tract, to be really dependable, must be done conscientiously, carefully and intelligently. When done in this way it is a good guide to an analysis or diagnosis of many obscure conditions, and I can see no reason for the fear which is expressed by some physicians that they may be harmful any more than the irrigation of any other cavity or organ in the hands of an experienced, capable operator.

During the last three or four years, it seems to me, a new element or microorganism has made its appearance in the intestinal field and has been bringing about more serious developments as time has gone on. There appears to be stasis of the intestines sometimes almost equal to a paralysis, indicating a contracture of the diaphragm. The patient comes in with a history that he has taken all sorts of laxatives and cathartics for a number of days as well as enemas, and could get no results. The most prominent symptom is flatulence, with pains simulating cholecystitis, appendicitis and other abdominal diseases, with shortness of breath; but the most harassing of all is periodic spells of deadly weakness or depression. The abdomen is distended, hard and lumpy (patients themselves using this expression).

Colonic irrigations are very reliable in relieving the symptoms, but there are recurrences, although after an initial course of treatments over a period of several weeks and a continuance of the irrigations, about once a month, with proper medication and diet the patients are comfortable.

Dr. de Rivas (closing): I have had no experience in treating parasitic infestation of the colon with short waves or conventional diathermy.

Fever Therapy — Finkelstein

(Continued from page 752)

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ARCHIVES of PHYSICAL THERAPY
OFFICIAL PUBLICATION AMERICAN CONGRESS OF PHYSICAL THERAPY

.·. EDITORIALS .·.

COMPLIMENTS OF THE SEASON

Yuletide and change of the calendar year are occasions for laying aside the humdrum cares of working days and for cultivating a spirit of good will toward our fellow men. This is also the season for taking stock and planning for the coming year not only in industry and commerce but also for the professional world. Especially we of the medical profession and devotees of physical therapy should utilize the customary rest period to reflect on the past and scan the future.

The year about to end has been one of progress and achievement for physical therapy. Though we have been unable to exclaim "eureka!" for all moot problems, we have gone far forward on the path of progress and can well pause with satisfaction for a short but well-earned day of relaxation and spiritual elation.

The year about to begin holds many promises of achievement. Under the favorable environment vouchsafed the American people there can be no doubt that we will not remain content to rest on our past laurels but will seek new fields to enlarge and enrich the domain of physical therapy.

It is in this sense that the officers of the CONGRESS and the editorial staff of the ARCHIVES extend to our members and readers hearty wishes for a merry Yuletide and a Happy and Prosperous Year 1939!

IMPORTANCE OF EXACT SHORT WAVE DOSAGE

Although it is generally accepted that short wave diathermy means a decided advance in the field of high frequency therapy, it is also generally recognized that this latest addition to physical medicine suffers from the lack of means to administer this therapy in such controlled dosage as is considered essential for modern scientific methods. The circumstance that up to now it has been a matter of necessity to gauge the intensity and control of this treatment by reliance on the subjective sensations of patients, admittedly has been a shortcoming of this otherwise valuable procedure. It is here exactly as with any other therapeutic measure which one is compelled to apply gropingly by the questionable manner of trial and error. Just as scientific medicine would not for a moment countenance the administration of any given powerful and standard drug by such vague dosage as is now tacitly sanctioned in this our daily practice, just so much short wave diathermy be controlled by a definite gauge if such a one can be found.

The crying need for exactness in short wave dosage is best shown by the fact that outstanding students in the related fields have devoted much time and energy to the solution of the problem and have voiced their desire for the adoption of a reliable method of measurement. When no less an authority than Kowarschik[1] among others, felt impelled to state that "If we had the possibility to measure that part of the current which flows through the patient, we could be completely satisfied, for we would then have a measure similar to that of ordinary diathermy. . . ," then it would seem that any further advocacy of continuing short wave diathermy treatment in its present empirical manner is tantamount to a declination of scientific exactness and progress. Guesswork at present

in our advanced state in the entire field of medicine is a reflection on individual ability and a denial of anything that makes for perfection.

Under the circumstances it is to be hailed as a great advance that after years of research the profession has been afforded a comparatively simple instrument for precise dosimetry. It can be coupled with virtually every short wave apparatus irrespective of its wavelength, and determines intensity or power of the high frequency current as actually absorbed by the patient under treatment, comparable to the simplicity of measuring the dosage in galvanotherapy or conventional diathermy. Although up to recently there have been advanced theoretical arguments for and against the practical feasibility of such direct measurement of short wave dosage, most exacting experimental and clinical tests have shown that the method under consideration is by no means one of conjecture or of purely theoretical value, but a reliable guide to the clinical application of short wave diathermy. It facilitates decrease or increase of intensity at the will of the operator and repetition of the identical dosage.

It will be recalled that during the present year there has appeared a considerable discussion[2] from which at this time it may not be amiss to quote a few of the salient arguments which in the light of the report published elsewhere in this issue by Mittelmann and Kobak[3] may be regarded as a rather historical record of the difficulties then extant that have since been overcome. Thus Schwarzschild[4] who was responsible for stimulatory more constructive discussions on this problem than any other single individual in America, gave expression to the assumed obstacles connected with the physical means of short wave dosage by pointing out the parallelism encountered between conventional and short wave dosimetry, and without actual experience with the method, pleaded that we should be "careful not to become overly optimistic, lest we assume a problem to be solved when, in fact, much more work must be done." Thus on merely theoretic reasoning he sees that — "The dosage problem in short wave may have a practical solution as satisfactory as that of conventional diathermy, but it has not yet been proposed." The simplest answer to this is contained in the dictum that facts should precede theories.

Against this speculative skepticism we have the matter-of-fact assertion by Kowarschik,[1] whose data are based on actual, clinical investigations. On this very problem this authority stated that it has been "shown how one can measure directly in watts the electric energy taken up by the body of the patient and, what is most important, has been technically solved." He further asserts that "personal experiments . . . have proved that for therapeutic purposes the measurement is adequately exact."

If further support be needed for the contention that a way has been found for scientific dosimetry in short wave diathermy we quote in part the following personal experiences of an accepted authority, Weisz,[5] of Vienna. He declares —

> We have found . . . a satisfactory method of dosimetry for short wave diathermy by measuring the density of the current passing through the skin. Physicists are agreed that the exact measurement of the current passing the body is not possible at the frequencies used in short wave therapy. Therefore we have to measure another responsible factor — at a certain disposition of the electrodes — for the rise of temperature within the tissues. Mittelmann's instrument measuring the power absorbed by the patient fulfills this demand. In addition, the measurement of power yields data independent of the wavelength employed.

From what has been said it will suffice to consider the principal facts presented by Mittelmann and Kobak above referred to, to appreciate that at this time the desideratum for precise dosimetry in short wave therapy has been realized. These authors have shown the simplicity and reliability of dosage control with a negligible amount of error factor. What is of particular importance

is that this system measures solely the power absorbed by the patient and has no relation whatever to the wattage output of the generator. The advantage of such a control is too obvious to require any further technical exposition.

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THE HISTAMIN FACTOR IN ULTRAVIOLET IRRADIATION

Of the fundamental biologic reactions produced with ultraviolet radiation, erythemogenesis was perhaps the first effect noted, but until recently the least understood. From antiquity to the present many opinions have been advanced about the nature and reaction of the skin to various dosages of ultraviolet radiation, and through this avenue alone one may often trace the mystical emergence of fact from faith as an index of the rational trends in this problem. Today it is universally appreciated that the latent erythema following ultraviolet exposure of certain wavelengths produces invariably a definite and constant inflammatory reaction of the skin, indeed so constant that it merits the designation of a specific biologic effect.

Its specificity first attributed to the products of inflammation could not however, fully explain the train of characteristic changes that paralleled the reaction associated with a histamin influence until Lewis'[1] theory of H-substance (histidine) stimulated further search in this direction. It is therefore interesting to call attention to the recent studies by Ellinger[2] of the Biological Institute of the Carlsberg Foundation of Copenhagen, who has contributed further confirmation of the presence of histamin-like substances in the skin. By means of controlled experiments he was able to demonstrate that skin activation by ultraviolet sources tends to follow a parallel clinical course to that of histamin when injected in a like group of animals.

Ellinger points out that irradiation of white mice is accompanied by loss of body weight and that this loss is related to stimulation of the thyroid gland as confirmed by the positive acetonitrile test of Reid Hunt[3]. The conclusion drawn from this observation suggested that the changes were so characteristic of symptoms associated with histamin intake (activation of thyroid gland and loss of body weight) that the truth could only be definitely established after comparative studies with histamin. Accordingly experiments were carried out by subcutaneous injections of histamin hydrochloride (0.01 to 0.04 mgm.) into each of a group of white mice. In the majority of instances (66 per cent) the effect was a lowering of body weight when the initial level of gland activity was normal or below normal, accompanied by a positive acetonitrile reaction as an index of thyroid activation.

These preliminary observations are further supported by Dietrich and Schwiegk[4] who point out that injections of histamin produce a higher blood flow in the thyroid gland as well as in other parts of the circulation, which in turn result in an increased function of the gland and stimulation of in-

ternal secretion. One may therefore anticipate that the new evidence in support of the biologic relationship of erythemogenesis of histamin-like absorptive changes will in the near future lead to additional discoveries as significant and concrete in their therapeutic indications as that of Vitamin D activation through irradiation of the sterols in the skin. Fundamentally it proves that the erythema factor is perhaps a more complex problem than heretofore regarded and may be associated with the stimulation of chemical products the understanding of which may bring about a new orientation of the scientific value of ultraviolet therapy.

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AMERICAN REGISTRY OF PHYSICAL THERAPY TECHNICIANS

IMPORTANT NOTICE

January 1, 1939 is the closing date for those eligible under waiver clause to register **without** examination.

January 1, 1940 is closing date for Junior registration.

For further information address Registrar, American Registry of Physical Therapy Technicians, 30 North Michigan Avenue, Chicago.

SCIENCE, NEWS, COMMENTS

New York Physical Therapy Society Meeting

The regular December meeting of the New York Physical Therapy Society was held at the Einhorn Auditorium of the Lenox Hill Hospital, December 7 at which the following program was presented:

1. New Instruments. (a) A New Thermometer for Internal Electrodes—*Jerome Weiss*, M.D. (b) A New Treatment Arm and Electrode for Short Wave Diathermy—*Heinrich Wolf*, M.D.

2. Paper of the Evening. The Problem of the Application of Long Wave Diathermy—*Heinrich Wolf*, M.D.

An Executive Session followed.

Northwestern University Offers Course In Neurology

Special evening course in physical therapy is announced as being offered at Northwestern University Medical School—Winter Quarter, which opens January 3, 1939.

This course deals with the practical aspects of disease of the brain, spinal cord and peripheral nerves. Emphasizing the anatomical and physiological basis for various clinical syndromes relating to the nervous system which are of special interest for the physical therapist.

Application for this course should be made before December 20, 1938.

All communications regarding this course and application should be made to John S. Coulter, M.D., Department of Physical Therapy, Northwestern University Medical School, 303 East Chicago Avenue, Chicago, Illinois.

Philadelphia Fourth Annual Postgraduate Meeting

The Philadelphia County Medical Society announces the completion of its scientific program for the Fourth Annual Postgraduate Institute to be held in the Bellevue-Stratford Hotel, Philadelphia, during the week beginning March 13th, 1939. The subjects to be considered are those embraced by the terms of Blood Dyscrasias and Metabolic Disorders. These will be further subdivided for convenience in instruction into eighty-six clinical lectures, with open forum discussion for each topic, delivered by as many individual specialists of national distinction. The Postgraduate Institute aims to fill this need and the participants may be assured that they will unquestionably profit by the program to be presented. All inquiries should be addressed to The Philadelphia County Medical Society, Twenty-first and Spruce Streets, Philadelphia.

Pacific Physical Therapy Association Meeting

The regular November Meeting of the Pacific Physical Therapy Association was held November 23, in the Orthopedic Hospital, Los Angeles, and the following program was presented:

1. Demonstration of Underwater Gymnastics, The Physical Therapy Department of the Orthopedic Hospital under the direction of *Miss Rowan;* 2. Fascial Transplant to Assist Weakened Abdominal Muscles Following Poliomyelitis, *C. L. Lowman*, M.D.; 3. Splinting of the Shoulder Girdle in Infantile Paralysis, *Robert L. Carroll*, M.D.; 4. Operation to Improve Abduction Power of Shoulder Girdle in Poliomyelitis Cases, *A. Brockway*, M.D.

Dr. Kovács Addresses Industrial Society of Medicine

Dr. Richard Kovács addressed the New York Society of Industrial Medicine on the afternoon of November 3 in Albany, on the subject of: "Physical Therapy in Fracture Treatment." The frequency with which his name has appeared as invited speaker before the many scientific societies in the Eastern littoral make one appreciate that his popularity has made his oratorical reflex so mechanized that he has but to hear the clang of a gavel to start him into a speech — time place and position not withstanding.

Correction Re: Dr. Bierman's Book

We regret that an inadvertent typographic error in the book review of Dr. Bierman's splendid contribution on short wave therapy was permitted to creep into the text. The number "810" in line 45 should have read 10^8 (ten to the eighth power).

American Chemical Industry No Longer Relies on Europe

The outbreak of war in Europe would find American industry, which was hard hit at the start of the last World War by a famine in chemicals and other technical materials made then only in Germany, so nearly self-sufficient regarding major chemical products that no serious crisis would result, a survey by Science Service disclosed.

American scientists, however, still dependent upon Germany technicians for the highest grade optical goods and scientific equipment, particularly of specialized types, might find their sources of vital apparatus dried up overnight.

Leading import into the United States from Germany last year was potash, to an amount worth

$6,668,000, an increase of more than $4,000,000 over the previous year. But, should war make it necessary, the United States could get along readily on American supplies.

Today the United States has one of the most powerful heavy chemical industries in the world, producing a wide variety of synthetic organic compounds ranging from dyes to explosives. The industry could be expanded to meet our own wartime needs; it already meets American demand and has some left over for export to other countries.

That was not the case at the start of the first World War, however. At that time the world's synthetic dye industry was almost entirely in German hands. Utter confusion resulted in the United States, partly because German patents contained only part of the necessary formulas or else formulas that were deliberately misleading. In addition to that, American chemists lacked the necessary experience for immediate application of such accurate information as they could get.

The Chemical Foundation was organized to meet this problem and to make German patents available to American industry.

Cameras worth $3,372,000, optical glass worth $318,000, and photographic paper worth $444,000 and other optical goods worth $746,000 were brought into the United States during 1937 from Germany.

Much of this equipment represents goods that compete directly with American products of similar grade, but a not inconsiderable portion consisted of instruments and materials it would be virtually impossible to duplicate in this country. Included in this last category, for example, are the planetaria which have been installed in several American cities by Carl Zeiss during the last few years.

Specialized laboratory apparatus, particularly in the glassware field, are in many instances made only in the Reich. These would be difficult, if not impossible, to duplicate either in this country or elsewhere in Europe. America does not import appreciable quantities of scientific equipment from other countries.

At one time the United States was dependent upon Germany for many of its better surgical instruments, but the situation has changed in recent years. Today, if America had to go to war or were blockaded, American soldiers would be treated with a completely adequate variety of American-made instruments.

A considerable quantity of medicinal preparations still come from Germany and from what used to be Austria. One such product is Prontosil, the first sulfanilamide compound. But American chemists have been making other effective varieties of this remarkable new curative agent. A temporary shortage in a few medicinals might be felt, but it probably would not last long.

Palm-kernel oil worth $4,644,000, used in the manufacture of lacquers and for other purposes, was sent to the United States from Germany last year. — *Science News Letter.*

Problems of Short Wave Diathermy — Titus

(*Continued from page 702, November issue*)

Dr. Norman E. Titus (closing): I call attention to that part of my paper dealing with dosage control, in order to enable me to reply to Dr. Eugene Mittelmann. I stated clearly that a knowledge of the total energy absorbed by the patient, measured in watts as suggested by Dr. Mittelmann, will not give a completely workable method of estimating effective dosages. It would only provide a means of controlling the maximum energy that it is desired to have the patient absorb. It is not known how this energy is distributed in the body, nor is anything definite known about the heating effect going on in each individual "cube" of tissue between the electrodes. It is impossible to predetermine the exact temperature rises of the various tissues.

There is no well defined area through which the short wave energy enters the skin and there is no way to determine how this energy divides up after it passes through the skin. The dosage density in the skin can not be determined, much less the actual dosage density in the deeper tissues. Assuming that Dr. Mittelmann's method measures the total actual energy absorbed by the patient, it can only help to set up empirical values for treatment.

Dr. Bachem's remarks are interesting. It must be remembered that many physicians do not sufficiently differentiate between *selective and specific effects of short wave energy*. Laboratory experiments have been conducted to determine the selectivity of heating human tissue in vitro with various wavelengths. Conclusions were drawn from these experiments as to the effect of these wavelengths in vivo. It must be remembered that in vivo there is a constant interchange of tissue fluids and blood, which tend to equalize the final temperatures. If one wanted to consider further the distribution of energy in vivo, it is only necessary to remember that the differences in field strength throughout any section due to geometric factors, most certainly would outweigh any small selective action. For a clearer study of this portion of the subject, I would refer those interested to "Medical Application of Short Wave Currents," by Dr. William Bierman.

Dr. Bachem says he has to contradict my statement "that fat and bone are not heated directly and may acquire some rise in temperature by thermoconduction from

(*Concluded on page 772*)

THE STUDENT'S LIBRARY

ESSENTIALS OF SHORT WAVE THERAPY. By *K. R. Speeding*, M.B., B.S., (Melb.), Diploma of Radiology (Edinburgh) with Foreword by Dr. *M. Crivelli*. Cloth. Pp. 119 with 19 plates and 42 figures and charts. Melbourne: W. Ramsay, (Surgical) Ltd., 1938.

This volume provides an astonishing commentary of how far innocent ambition can stimulate the individual to "a rage for writing" in fields partially mastered or of facts incompletely digested. One fails to see any extenuating circumstances that would plead the need for such a work in the light of more informative texts on short wave therapy within reach in every important language. It can be asserted without fear of contradiction that the English editions occupy a ranking position both for detail of scientific information and for linguistic clarity and artistic format. The author's prime reason for his literary venture is that he offers a "conveniently-sized manual which will incorporate facilities both for comparative study, and for further investigation." The hope being father to the act a manual is presented for guidance in short wave therapy in the space of four chapters preceded by a benedictory foreword and succeeded by some sixty odd references and an index. Says Dr. Crivelli in his foreword: "All medical men will certainly feel, after reading this excellent little volume, that it has been needed and that it appears at an opportune time to clarify the ideas of the profession on the real value of the treatment known as short wave therapy . . . . " Such an opinion merits no other comment than that it is the figment of an optimistic imagination, for as already hinted, this "little volume" fills no pressing need because of the more scholarly and detailed expositions already published, known to and quoted by the author for support of his own book. Throughout the text one encounters linguistic and technical laxities as to indicate a careless attitude for syntax and a questionable appreciation of the value of line drawings for illustrative purposes. From the half-tone frontispiece to the one on second from the last page one encounters pictures of impressive looking boxes whose internal contents are as meaningless as the invisibility of their circuit. How informative is a manual that occupies much of the space with illustrations of pretty or impressive cabinets, or with line drawing of electrodes placed over one's trouser seat or coat tails, or in other impossible places and positions? How acceptable can such an exposition be when its very skeleton, integuments and muscular structure are drawn from what others have already created and demonstrated? One finds that even the majority of half-tones have been borrowed, nay, even some of the more representative line drawing, to support a patchwork of literary effort that neither comes up to the dignity nor informativeness of those scientific contributions which it has drawn upon to support the author's own clinical experience and views on short wave therapy.

CLAUDE BERNARD, PHYSIOLOGIST. By *J. M. D. Olmstead*, Professor of Physiology, University of California. Cloth. Pp. *272* with illustrations. Price $4.00. New York and London: Harper & Brother, 1938.

This work is an inspiring biography of one of the most extraordinary of scientists who though he lived, suffered, created and died on French soil, attained the posthumous distinction of the name of father of modern physiology. It is the fascinating story of the obscure youth risen to fame without material fortune, of sweet sorrow in the midst of acclaim and of the rigid organization of body and mind for the single purpose of greatest creative effort in his chosen field. The theme of this biography shows Claude Bernard to have delved deep in the majesty of contrasting emotions — hope and love, marital unhappiness and disappointments that led to long illness, but throughout which the pursuit and organization of his research never relaxed until nature placed his fame in the hands of posterity. Bernard was the product of that inexplicable era during which the extraordinary and the superlative talents in France rose above a populace of impoverished mediocrity. The latter half of the nineteenth century saw the rise of a galaxy of new stars who created in vivid and majestic tones on canvas and stone, whose writings and song have become unmatched in style of depth and breadth and brilliance of its themes, whose pioneers in science opened new pathways in bioelectricity (Duchenne in electrodiagnosis and d'Arsonval in high frequency therapy), in biochemistry with Pasteur and in physiology with Bernard. An interesting sidelight first to have its appearance in an English biography is here related about the influence of Bernard on the future of a young *externe* from the hospital de l'Enfant Jesus, d'Arsonval, who came out of curiosity to listen to the lectures on blood and blood sugar. Failure of Bernard to demonstrate temperature differences because of the misbehavior of his galvanometer prompted the young externe to ask permission to examine and then to repair it. Bernard's interest in this young student increased when in the course of his interrogations he discovered that his guest was the son and grandson of country doctors, and that d'Arsonval's father had even been the assistant of Laennec who had held Bernard's chair before Magendie. Thus by the grace of Fate and Bernard's influence a potential country doctor became the assistant, disciple, and later his successor to the chair of physiology and achieved undying fame in his own name by discovery of high frequency current in medicine.

Within such a fascinating frame is depicted the life and contributions of this great French savant whose human qualities and searching inquiries are presented in a critical and sympathetic style. Such also is the impression of Alexis Carrel who in his foreword states: "Dr. Olmstead describes the dis-

coveries of Bernard, his method, his attitude toward the mystery of life, with a profound knowledge of their importance. But also with a love inspired by their beauty." Divided into three sections, the volume records his life, marital unhappiness, professional activities; his contributions to the science of physiology by reviewing his original studies on pancreatic digestion, glycogenic function of the liver, vasomotor nerves, action of poisons, the role of internal secretions, and the like. It can now be asserted that no other man has contributed more richly, vitally and honestly to the subject of human physiology than Bernard. His posthumous notes have been found so rich in truths that modern science has given him ranking position over his more spectacular and brilliant contemporary, Pasteur, exemplified in their opposite views on fermentation, which required eighteen years to prove the correctness of Bernard's position. Though Pasteur outshone Bernard in the dramatic nature of his achievements, posterity has acclaimed the latter as the greater scientist.

THE PITUITARY GLAND. An Investigation of the Most Recent Advances. Proceedings of the Association for Research in Nervous and Mental Disease, December 28th and 29th, 1936. Vol. XVIII of a Series of Research Publications. Editorial Board: *Walter Timme, Angus M. Frantz, Clarence C. Harr.* Cloth. Pp. 764 with colored and half-tone illustrations. Price, $10.00. Baltimore: The Williams & Wilkins Company, 1938.

Of the excellent volumes published by the Association for Research in Nervous and Mental Disease in the past eighteen years none has been of a more timely character nor more scholarly in its survey of its theme than this its latest in this series of publications. The work reviews the problem of the pituitary gland from three important considerations: its anatomic relationship, its physiologic action, and its general influence on function, specific or special metabolic role, clinical behavior and therapeutic action, and the like. Though divided into three major sections, it provides 42 special chapters of highly informative material written by the most authoritative individuals from outstanding scholastic institutions. The data presented are so extraordinarily rich in content as well as in implication as to make it encyclopedic in scope. This opinion is perhaps best exemplified by a more detailed review of several of the chapters selected at random. The first by Tilney reviews the glands of the brain in such detail that it provides one of the best digests on this relatively unknown study in relation to medicine. The chapter by Severinghaus on the cytology of the pituitary gland offers by its clarity, detail and scholarly survey one of the best reviews on the morphologic differentiation of histologic structure. The fact that it includes an appended bibliography of about nine closely printed pages suggests that here is provided the richest source of collateral reading. Collip's dissertation on the physiologic nature of ante-hormones contains the virtues of brevity without sacrifice of facts. The chapters on the physiologic nature of the much discussed prolactin factor, the influence of the pituitary gland on puberty, pregnancy and menopause are all presented with the critical eye for truth, detail and concision even when presented by different individuals. The problem of water and carbohydrate metabolism in man and mammals is cogently discussed by Ransom, Fisher and Ingram in a manner to stimulate a train of speculation of the far-reaching importance of the hypothalmico-pituitary mechanism in diabetes. This is carried a step farther by Sittenfeld in his exposition on the "influence of the anterior lobe of the pituitary on the growth of sarcoma and cancer." Sittenfeld presents certain important observations and conclusions such, for instance, that "castration of susceptible mice when they are two or three months old renders them non-cancerous in 100 per cent" — thought provoking in its deduction because it suggests a gonadotropic influence on malignant growth which has in the past two years been observed on humans by Samuels of Holland. From what has been said it is clear that this volume offers one of the best surveys of this important subject by a group whose scholarly background is sufficient recommendation of the authenticity and timeliness of the facts presented.

THE RADIOLOGY OF PULMONARY TUBERCULOSIS. By *J. E. Bannen*, M.B., Ch.B., D.M., R.E. Hon. Radiologist: Hull Royal Infirmary, etc. Cloth. Pp. 156 with 39 illustrations. Price $4.50. Baltimore: William Wood and Company, 1937.

This concise exposition of a topic richly discussed in the medical literature merits attention because it not only offers a complete digest of the essential facts related to the diagnosis of tuberculosis and allied affections of the lungs but because it presents in an informative manner the roentgenologic evidence upon which such diagnostics are largely dependent. From the point of view of the roentgenologist the author has introduced into the text radiographic pictures as suitable companion illustrations to the exposition of the pathologic processes therein reviewed in order to present the subject in the briefest and clearest dimensions. Because the physical and radiological findings of each given instance may be extremely diverse he has attempted the difficult task of presenting the important and salient feature in what might be regarded as composite studies. To render this more authentic he was assisted by the able advice of authoritative colleagues for which acknowledgment is given. In the space of nine chapters the exposition carries one through such correlated topics as technic of chest radiography; the normal lung and the pathogenesis of pulmonary tuberculosis, especially of the adult type; its differential diagnosis and clinical aspects. The text also includes a chapter on pneumoconiosis which emphasizes certain industrial diseases, and closes with a short review of collapse therapy. It is surprising the wealth of information introduced and gratifying how clear and detailed are the accompanying illustrations. Appended after each chapter is a well selected and generous bibliography, and at the end a detailed index. The author and publishers are to be felicitated for their combined labors to make this an informative and pleasing contribution.

PROCEEDINGS OF THE XV INTERNATIONAL PHYSIOLOGICAL CONGRESS (Abstracted in the Sechenov Journal of Physiology of the U. S. S. R.). Edited by *L. N. Fedorov, S. M. Dionessov,* and *A. V. Eisenberg.* Paper. Pp. 640 with illustrations. Price $15.00. Leningrad and Moscow: The Biological and Medical Press, 1938.

This volume incorporates the scientific transactions of the Fifteenth International Physiological Congress held in Leningrad and Moscow on August 9 to 16, 1935. It is fittingly dedicated to the master of Russian physiology, the venerable Ivan Petrovich Pavlov, who as President of the Congress lived long enough to realize one of his cherished ambitions: namely, to demonstrate his country's progress and achievement in this important field of science. Pavlov's death six months after the close of this session, at the age of 87 years, permitted the eulogy of Orbeli as an introduction to this volume which pointed out his brilliant services in his chosen field. Although dead, his remarkable and penetrating labors will long live as an example of the classical investigator who eventually became known for his lucid exposition of the most profound researches in the physiology of gastric secretion. Orbeli in his eulogy of this great Russian physiologist refers to his sixty years of unflagging service, his unmatched capacity for prolonged mental effort, and his rigid control of his physical and mental powers that enabled him to work with clear vigor up to his eighty-sixth year. Rewarded with the Nobel prize for his early work on the physiology of digestion, it is significant that his creative efforts during the last thirty years were in the construction of a new scientific method of objective study of the higher nervous activity, which gave rise to the science of conditioned reflexes. And though this volume offers over 600 abstracts of the most progressive research in contemporary physiology as well as addresses of other Nobel prize winners and commments of perhaps the greatest leaders in this field, one cannot help but feel that Pavlov's presence was the spiritual halo that hovered over this congress and gave it greater moral impetus than was generally appreciated. The final impression after the perusal of the hundreds of abstracts was that while many of these studies will no doubt be judged as of great scientific worth, his was the moving spirit that was accorded frankest admiration and veneration by the delegates, world famous in their own right. For those interested in the Medicine of tomorrow, one must read this volume with studious love and care, because the most important communications read at this International Congress are incorporated or indexed in this work.

THE 1938 YEAR BOOK OF PHYSICAL THERAPY. Edited by *Richard Kovács,* M.D. Cloth. Pp. 486 with illustrations. Price $2.50. Chicago: The Year Book Publishers, 1938.

The present volume is the most recent addition to the Practical Medicine Series of Year Books, and will attempt to survey in abstract form the yearly contributions in physical therapy. Its international scope is shown by the many references to foreign and domestic contributions, all of which carry information of a practical and special character. The author has presented his extensive material under two major generic groupings: Physical Therapy Methods and Applied Physical Therapy, under which is discussed in abstract, the past year's contributions to electro- and fever therapy; light, infra-red and ultraviolet therapy; hydro- balneo and climatotherapy; mechanotherapy; physical education and institutional problems. Many of the abstracts have had the benefit of terse editorial comments, to indicate the import, trend and practical value of the diverse agencies used in physical medicine. These include such far flung topics as the applicability of physical agents in abdominal and arthritic disease; cardio-renal conditions; skin and peripheral vascular diseases; fractures, injuries, disabilities; gynecologic and proctologic diseases; nervous and mental conditions; and affections of eye, ear, nose and throat. There is no question as to the practical value of this new volume for the medical profession. It is an easy, readable and handy reference to the latest advances in physical therapy and its low cost places it within reach of every one interested in this rapidly developing field. We offer hearty felicitations to author and publishers for their special contributions to this problem.

BRITISH PERIODICALS OF MEDICINE. A Chronological List. By *W. R. Lefanu,* M.A., Librarian, Royal College of Surgeons. Boards. Pp. 93. Price, $1.25. Baltimore: The Johns Hopkins Press, 1938.

This small brochure embodies a chronologic survey of British periodicals in medicine which indirectly points out the rise and decline of medical fashion from the 17th century to publications born approximately at the beginning of 1900. Since this study is concerned with publications of the British Empire, it is not surprising that this survey incorporates 1362 journals of general or specialistic types that have played a role in the progress of British medical science. It is interesting to note the increasing number of these titles in the past three centuries and its influence on its time, exemplified by the new and important advances in medicine under their changing titles. It shows the rise and decline of medical fashion by the birth and demise of such periodicals as "The Mesmerist — a Journal of Vital Magnetism"; "Peoples (The) Phrenological Journal and Compendium of Mental and Moral Science"; the evolution of changing thought and practice in journals under the titles "Sunlight," "Healers," "Health," "Homeopath," and the like. Even the well known publication of the British Journal of Physical Medicine is shown to trace its origin first, from "Modern Sunlight" and then from "Actinotherapy and Physiotherapy." Thus the present volume in keeping with the work initiated by the late and learned Fielding H. Garrison who first suggested the compilation of this list, offers valuable information for those who wish to delve deep into this interesting branch of medical history. This scholarly contribution is both timely and practical for students of medical literature.

Problems of Short Wave Diathermy — Titus

(*Continued from page 768*)

the heated surrounding tissue of low electrical resistance." This statement was made in reference to heating with electromagnetic induction and not with air-spaced electrodes.

I most heartedly have to disagree with Dr. Disraeli Kobak. He seems to draw the conclusion that I have stepped on the toes of the physicists and radio engineers. As we are definitely concerned with the maximum temperatures attainable in the body tissues, I can not see how the physicists or radio engineers can make this determination in any better manner than we can as physicians. Certainly the physicists can not insert thermocouples and cannulas in the body tissues without our aid. This procedure must be used for these measurements. As the temperatures cited in my paper are taken from the published reports of the Council on Physical Therapy of the American Medical Association and also from the reports of experiments performed at Northwestern University, I believe it is proper to draw conclusions from these experiments.

Dr. Kobak talks about the effectiveness of a fifteen meter or longer wavelength with the use of the induction coil. As it is generally agreed that heating of tissue is the all important effect of the electromagnetic or electrostatic field as used in short wave therapy, I would say that Dr. Kobak is definitely in error. To attribute superficial heat concentration to the capacitive field, when all these tests were made to patient's tolerance, indicating the same skin temperatures and when the final intramuscular temperatures reached for the magnetic or electric field are of the same magnitude, is to permit wishful thinking to take the place of proper analysis. I am of the belief that no treatment is ever given that has a purely electromagnetic or electrostatic effect, but that there is a predominance of either according to the technic used. The treatment leads have both capacitive and inductive impedance. As stated in my paper, the more turns used in treating with the induction cable, the greater the electric field; the fewer turns used, the greater the magnetic field effect. Since both these fields produce heat, we are concerned only with the final temperatures that can be attained. These temperatures show that the final intramuscular temperature is independent of wavelength. All the tests were conducted with four turns around the thigh. With the shorter wavelengths the induction cable produces its heating in a manner similar to cuff electrodes.

I believe the statement made by Dr. Kobak as to the higher voltages necessary at the treatment electrodes in order to overcome spacing, was discussed in the main part of my paper. There are other differences, however, that must be considered when comparing air-spaced electrodes with spaced (felt or toweling) pads. Increased air-spacing reduces the effect of irregularities in the body surfaces, thus avoiding concentration of energy due to this cause. It also increases the size of the approximately equivalent contact electrode, thus producing a more even field distribution throughout the tissue. When using spaced pad electrodes, concentration of the energy may occur in a layer of sweat absorbed by the felt. The high salt content of the sweat particles makes a good conductor. As the spacing material becomes saturated with this sweat, its dielectric value becomes considerably reduced. This can not occur when actual air is used as the dielectric for spacing.

It is not to be assumed from the factors enumerated in this paper that high temperatures are desirable therapeutically. Often these high temperatures are contraindicated. I have been concerned only with the maximum heating that could be produced in tissues with the various wavelengths employed in short wave therapy without causing destruction. All tests were made to individual tolerance. This amount of energy can be decreased when necessary but it should be available for use. As stated in my paper, the custom at present of giving large doses is contrary to experience gained with conventional diathermy. The question of biologic effects of subminimal doses is still wide open and it seems that stimulation of function of organs of the body, either those of internal secretion or others, depends upon the stimulation of the circulation in these organs. This is due to the attempt of the body to equalize the temperature of the organ when it is increased with high frequency currents.

To emphasize, the essence of the whole situation is that we do not want to cook and destroy any body tissues. Mittelmann has helped the situation by giving us a method of estimating the total energy absorbed by the patient. That will be a guide against coagulation of tissue. What we do want, however, is to create just sufficient heat to cause a local physiologic hyperemia in an attempt to relieve pathologic congestion and increase the biologic function of organs. The optimum dose for this is still unmeasurable, but does not seem in any way dependent upon wavelength. Different technics are necessary for the successful accomplishment of this reaction and apparatus should permit the application of the best suited technic.

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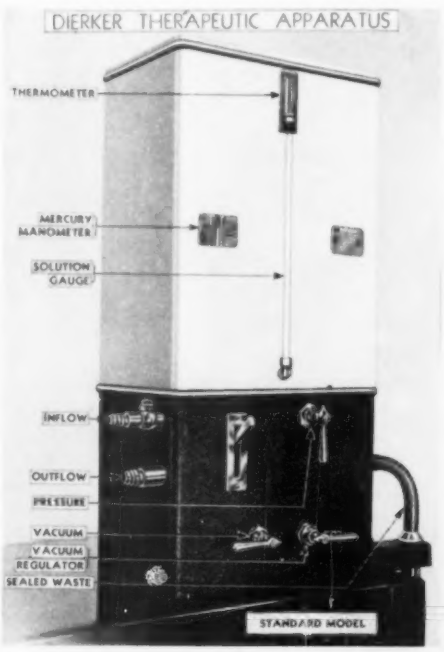

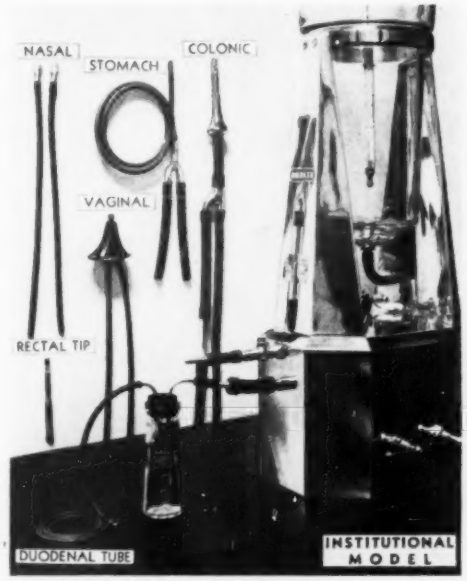

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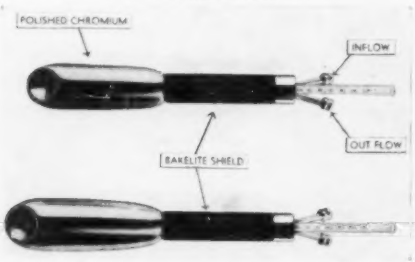

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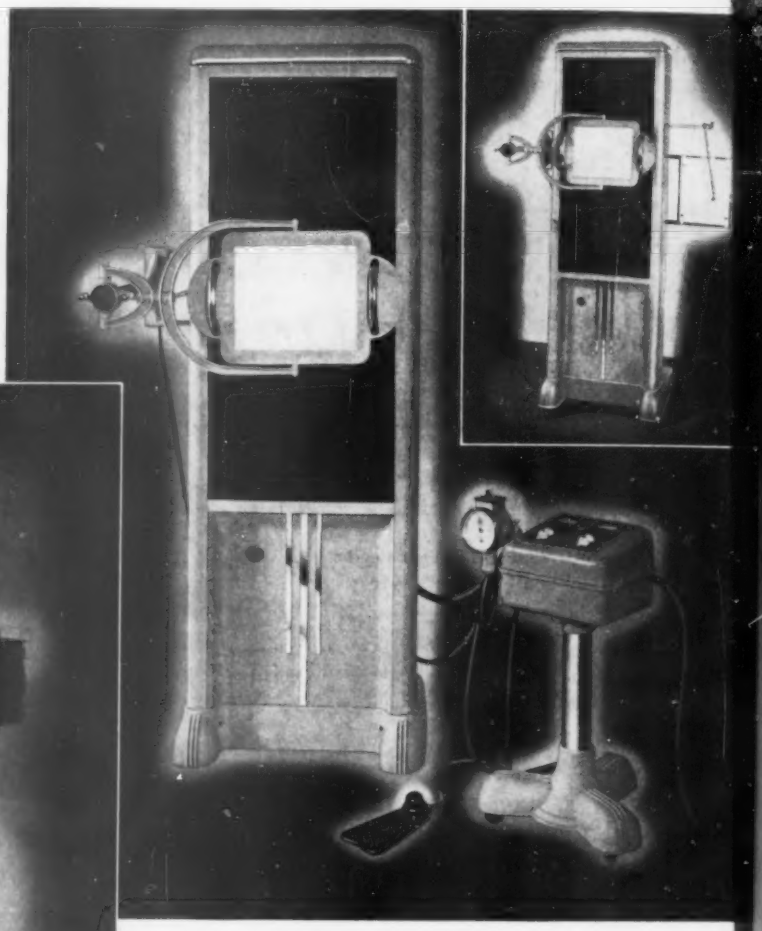

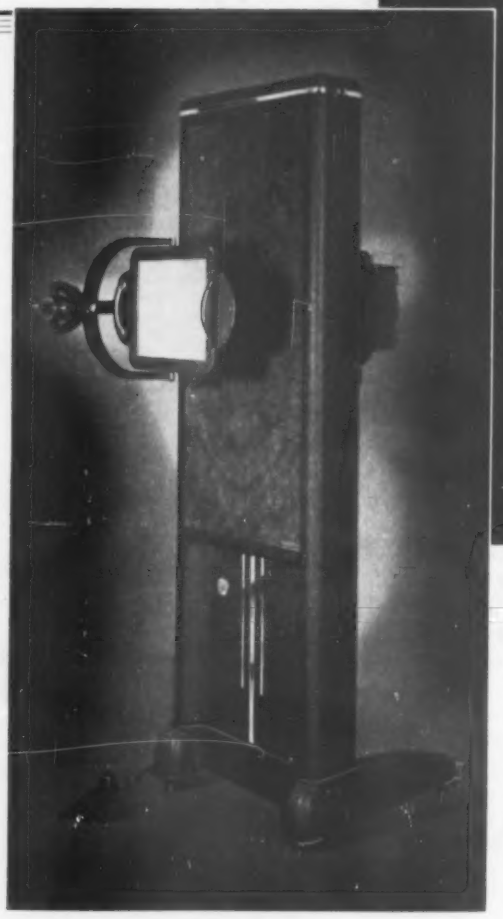

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